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Supreme Court of the United States

October Term, 1929

No. 71

MINERALS SEPARATION NORTH AMERICAN CORPORATION,
Petitioner-Plaintiff,

—vs.—

MAGMA COPPER COMPANY,
Respondent-Defendant.

BRIEF FOR PETITIONER-PLAINTIFF

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Supreme Court of the United States

OCTOBER TERM 1929.

No. 71.

MINERALS SEPARATION NORTH AMERICAN CORPORATION,
Petitioner-Plaintiff,
—vs.—
MAGMA COPPER COMPANY,
Respondent-Defendant.

BRIEF FOR PETITIONER-PLAINTIFF.

GENERAL STATEMENT.

This is a suit in equity originating in the District of Maine for infringement of Letters patent No. 962,678, claims 1 and 2.

The Circuit Court of Appeals for the First Circuit (Bingham and Johnson, *C. Js.*) held the patent anticipated by plaintiff's earlier patent No. 835,120 and directed that the Bill be dismissed (Anderson, *C. J.* concurring in the result) (R. Vol. I, p. 639, 30 Fed. [2d] 67), refusing to follow the contrary decision of the Circuit Court of Appeals for the Third Circuit in *Minerals Separation, Ltd.* v. *Miami Copper Company,* 244 Fed. 752.

The Circuit Court of Appeals for the Third Circuit in the said *Miami* case had followed this Court in this Court's elucidation in *Minerals Separation, Ltd.* v. *Hyde,* 242 U. S. 261, of the invention of plaintiff's earlier patent aforesaid No. 835,120 (an elucidation later confirmed by this Court in *Minerals Separation, Ltd.* v. *Butte & Superior Mining Co.,* 250 U. S. 336), reaching in consequence its conclusion that the patent in suit No. 962,678, claims 1 and 2, was not anticipated by patent No. 835,120, and was valid and infringed.

The documents compared were the same in the two cases and the proofs there included substantially the same prior art against patent No. 962,678, claims 1 and 2, that is presented in the instant case.

The Circuit Court of Appeals for the First Circuit in the instant case (or a majority of that Court) refused to accept and follow the said decisions of this Court as to the nature of the invention of the earlier patent No. 835,120 and disregarded and over-rode those decisions, reaching in consequence thereof its majority conclusion that the patent in suit No. 962,678 was anticipated by patent No. 835,120.

Petition for Writ of Certiorari was granted May 20, 1929 (R. Vol. I, p. 659).

The jurisdiction of this Court rests upon the Judicial Code.

ARGUMENT.

The opinion of the Circuit Court of Appeals in the instant case deals only with one defense, namely, the defense of alleged anticipation of the patent in suit No. 962,678 by patent No. 835,120. It does not deal with the other defenses that were argued by the defendant in both Courts and overruled by the District Court. We shall therefore discuss in this brief the defense of alleged anticipation of the patent in suit No. 962,678 by patent No. 835,120, as to which the two Circuit Courts of Appeals for the First and for the Third Circuits are in conflict.

The issue of fact on which the two Circuit Courts of Appeals are in conflict (namely, whether patent No. 835,120 anticipates patent No. 962,678) turns on the nature of the invention of the earlier patent No. 835,120, and as to that this Court has authoritatively spoken.

To briefly define the issue:

Both patents concentrate ore by mineral-froth flotation.

Both utilize the lifting force of air bubbles to raise the mineral particles into the form of a froth lying on the top of the pulp.

They differ as to the agent and the principle by which that lifting force is made to select the mineral particles in prefer-

ence to the gangue particles and as to characteristics of the mineral-bearing froth produced.

Patent No. 835,120 employs *an oil or oily substance* as the agent, oleic acid being the one example given. This oil or oily substance by reason of its preferential affinity for mineral particles over gangue particles (well known long before patent No. 835,120) oil-coats the mineral particles in preference to the gangue and if the oil quantity is minute enough (a fraction of one per cent on the ore) a mineral froth results from aeration and agitation and rises through and out of the pulp, the froth carrying the oil-coated mineral particles.

Patent No. 962,678 employs a mineral-frothing agent that dissolves in the water of the pulp and therefore does not and cannot coat the mineral particles, preferentially or otherwise, but so modifies that water that upon aeration and agitation a mineral froth results and rises as before, carrying the uncoated mineral particles.

The Circuit Court of Appeals for the First Circuit in the instant case nevertheless found patent No. 962,678 anticipated by patent No. 835,120 on the unproved and indeed disproved hypotheses that the agent in solution of patent No. 962,678 really also coats the mineral particles and that the coating agent of patent No. 835,120 really also goes partly or wholly into solution and that that solution really produces the froth, and that both therefore act on the same principle and are the same process.

But that Court disregarded the fact proved that the alleged coating of mineral particles by the agent in solution of patent No. 962,678 was not a coating at all but was at most a negligible increase or decrease in the strength of the solution wherever the solution came in contact with any surface, either a mineral surface, a gangue surface, an air surface, or a tank bottom or wall surface. An increase in the strength or concentration of the solution at a surface is known as "positive adsorption" and a decrease or dilution as "negative adsorption." It was proved that there was no relation whatsoever between the adsorption phenomena and the carrying on of the process of the patent in suit, No. 962,678, since the process was carried on

whether the adsorption was positive or negative, and could be carried on with some soluble substances that produced positive adsorption and could not be carried on with other soluble substances that produced positive adsorption; and it was not proved that adsorption acted preferentially at any surface.

And that Court also disregarded the fact, admitted by defendant's experts, that the solubility of the oleic acid of patent No. 835,120 in the water of the pulp was of the same order as the solubility of window glass in rain water and was altogether negligible in the process of patent No. 835,120.

In all this the Circuit Court of Appeals for the First Circuit proceeded upon speculative theories propounded by defendant's experts, unproved and in fact disproved, and disregarded the simple description that this Court had given of the process of patent No. 835,120 and the definition that this Court had given of the "oils or oily substances" of that patent.

Patent No. 835,120 was before this Court on two occasions. On the first occasion (the *Hyde* case, *supra*) for novelty, utility and validity; on the second occasion (the *Butte & Superior* case, *supra*) for determination of the scope of claims on a question of infringement which turned on the definition given to the "oils and oily substances" of that patent.

This Court in the *Hyde* case quotes from patent No. 835,120 (242 U. S. 263):

> "the object being to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue."

It then interprets that language as follows (242 U. S. 264):

> "It is clear that in the prior art, as it is developed in this record, it was well known that oil and oily substances had *a selective affinity or attraction for, and would unite mechanically with,* the minute particles of metal and metallic compounds found in crushed or powdered ores, but would not so unite with the quartz, or rocky non-metallic material, called 'gangue.' Haynes British patent (1860), and United States patents, Ever-

son (1886), Robson (1897) and Elmore (1901). It was well known that *this selective property of oils and oily substances* was increased when applied to some ores by the addition of a small amount of acid to the ore and water used in process of concentration. United States patents, Everson (1886), Elmore (1901), and Cattermole (1904)."*

Then this Court says (242 U. S. 267) after describing in detail the discovery of the process of patent No. 835,120 in the course of experiments with oleic acid as the agent in a Cattermole metal-sinking process:

> "It was promptly recognized by the patentees that this froth [of the process of No. 835,120] was not due to the liberation of gas in the mass treated by the action of the dilute acid used [chemical action] and its formation was at once attributed in large part to the presence of the air introduced into the mixture by the agitation which had been resorted to to mix the oil with the particles of crushed ore, which air, in bubbles, attached itself to the mineral particles, *slightly coated as they were with what was necessarily an infinitesimal amount of oil,* and floated them to the surface."

And later after stating agreement with the decision of the House of Lords in *Minerals Separation* v. *British Ore Concentration Syndicate, Ltd.*, this Court quoted from that decision as follows (242 U. S. 269):

> "And Lord Atkinson said: 'In their process this *mysterious affinity of oil for the metallic particles* of the ore is availed of, yet the oil is used in such relatively infinitesimal quantities *that the metallic particles are only coated with a thin film of it,* and the lifting force is found not in the natural buoyancy of the mass of added oil, but in the buoyancy of air bubbles, which, introduced into the mixture by the more or less violent agitation of it, envelop or become attached to, *the thinly*

* Unless otherwise indicated, bracketted portions and italicizing in quotations will be ours.

> *oiled metallic particles,* and raise them to the surface, where they are maintained by what is styled the surface tension of the water'."

In the *Butte & Superior* case this Court reviews the prior proceedings and quotes portions of its prior decision, and says (250 U. S. 341, 342):

> "the language quoted seems to indicate clearly enough that the opinion of the court then was, as it is declared now to be, that as to the claims here involved the patent *extends to and covers the use in the process of oils of the patent, in amounts equal to any fraction of one per cent.* on the ore."

This, it will be noted, introduces the term "oils of the patent" which is repeated many times in the decision and which is repeatedly held to mean "oils having a preferential affinity for metalliferous matter," as stated in the specification of the patent.

Then this Court considers the question "whether petroleum products or derivatives used by the respondent were oils within the scope of the patent" and remarks (250 U. S. 343):

> "It is admitted that petroleum products are 'oils having a preferential affinity for metalliferous matter'."

and in the course of its reasoning says (250 U. S. 349):

> *"the only disclosure* as to the kind and amount of oil which the patentees made to the public as necessary to the practicing of their process is that it must be an oil or oily substance, or oily liquid having a *'preferential affinity for metalliferous matter,'* and that it shall be limited in amount 'to a fraction of one per cent. on the ore'."

It is therefore clear that this Court has decided, as to the "kind of oil," that patent No. 835,120 discloses

> "that it must be an oil or oily substance, or oily liquid having a *'preferential affinity for metalliferous matter',"*

to the end that it may *preferentially coat that metalliferous matter* and thereby determine its predominance in the froth and the ore concentration achieved by that predominance.

The Circuit Court of Appeals for the Third Circuit in the *Miami* case having both patents before it, No. 835,120 and No. 962,678, and the decision of this Court in the *Hyde* case, said of patent No. 962,678, the patent here in suit (244 Fed. 771), after considering patent No. 835,120 and its validity:

> "It is also an air-froth flotation process, but differs from the first patent, although both processes may be, and both actually are, employed conjointly. Its essential feature is the use of a mineral-frothing agent in solution."

Later that Court said (244 Fed. 773):

> "The difference between the two patents may be shortly stated to be this: The first process rests upon the use in very small quantity of an oily substance that does not dissolve in water, coupled with agitation of the pulp, and this succeeds in producing a special froth that is remarkably effective in recovering the minute particles of ore. The second process does not employ oil, or an undissolvable substance; on the contrary, the 'mineral-frothing agent' must be in solution, and *ex vi termini* must therefore be dissolvable. * * *
>
> "We do not find it necessary to discuss the question of validity; our conclusion is, that the patent discloses invention and has not been anticipated. As in the case of the oil process, the patentees seem to have taken 'the final step which converted experiment into solution, turned failure into success.' *Minerals Separation Co.* v. *Hyde,* 242 U. S. 261, 37 Sup. Ct. 82, 61 L. Ed. 286. And we find nothing in the prior art that can be held to anticipate."

In this situation the District Court in the instant case said of the two decisions of this Court (Vol. I, pp. 620, 621):

> "I consider that the decisions of the Supreme Court in the *Hyde* case and in the *Butte* case, above mentioned, are in harmony with the position of the plaintiff rather

> than with that of the defendant. The Court evidently regarded the first patent as a process patent limited to the use of oil or oily substances. In the *Butte* case, involving the first patent, the Court confirmed to the patentees their process claims involving the use of any of the class of oily (insoluble) mineral-frothing agents that acted by preferential affinity in coating the mineral. By implication it confirms to the patentees here their process claims involving the use of any of the class of soluble mineral frothing-agents that act on the different principle of going into solution, not coating the mineral, but modifying the water in some unknown way, to accomplish the same result in the end, *i.e.*, bringing up to the surface the mineral particles attached to the froth."

and again (R. Vol. I, p. 621):

> "It seems to me that the principle defenses must fail for the reason that they are based on a theory of difference between the two patents that apparently would not be accepted by the Supreme Court, according to my interpretation of its two decisions."

As to the *Miami* decision the District Court said (pp. 621 and 622):

> "But, however that may be, these and the other more technical defenses were doubtless considered by the Circuit Court of Appeals in the Third Circuit in the suit of *Minerals Separation, Ltd.* v. *Miami Copper Company*, 244 Fed. 752, involving the validity of this same patent and, while the parties were not the same, I am practically required to follow that decision, based upon substantially the same facts, unless manifest error clearly appears.
>
> * * *
>
> "I think no one who studies the evidence, the diametrically opposed theories of the experts and the elaborate arguments in this case, can say conscientiously that it 'clearly appears that there was manifest error' in the decision of the Circuit Court of Appeals in the Third Circuit. The most that can be said seems to me to be that possibly other minds might take a different view

> of the fundamental difference between the two patents, in which case, unless the decisions of the Supreme Court are construed to impliedly prevent arguments of defendant's counsel based on anticipation and non-patentability would be very persuasive. However, that possibility is far from a situation justifying me in departing from the previous decision and consequently, for me, 'it would be unseemly not to follow a decision which is entitled to the greatest respect * * * determining the title to the same property.'
>
> "It follows that the patent is held valid."

Nevertheless the Circuit Court of Appeals for the First Circuit in the instant case has come to the opposite conclusion, namely, that the agent in solution of the process of patent No. 962,678 has preferential affinity for the mineral particles over gangue and coats them and not the gangue, like the agent of patent No. 835,120, and thereby the Circuit Court of Appeals for the First Circuit has broken down and overridden the definition of "oils of the patent" of patent No. 835,120 given by this Court as above set out (which definition had been followed by the Circuit Court of Appeals for the Third Circuit in the *Miami* case and by the District Court in the instant case) *by including within its terms any and every mineral-frothing agent without discrimination.* And in so doing it has disregarded also the conclusive evidence in the record to the contrary.

That evidence in part took the form of *demonstrations* which were witnessed by the District Court and then described in the record but which the Circuit Court of Appeals for the First Circuit declined to witness.

1. At the trial a demonstration (called the first experiment) was made of the process of patent No. 835,120 *with oleic acid as the agent* (the one and only substance specifically given as an example in that patent), and it was admitted that if this were followed by a careful washing of the resulting froth concentrate with warm water and then by a repetition of the process with a pulp consisting of that so washed concentrate and fresh water, but without the addition of any oleic acid, *a full mineral froth would rise as at first.* (R., Vol. I, pp. 395-397;

pp. 447, 448, Qs198-200; p. 451, Q215.) *This located the active principle in the coating on the mineral particles.*

It was also proved that during the operation of the process of patent No. 835,120 the oil was practically completely removed from the pulp liquor by the froth and that that pulp liquor was thereafter of no further use in the process without the addition of further oleic acid (Higgins, R., Vol. I, p. 451, Q215; pp. 591, 592, Qs796-800). That is to say, it was proved that with this once used pulp liquor and fresh ore and agitation, *no mineral froth whatever was formed or rose.* Everything sank together to the bottom. *This negatived the location of any active principle in the water of the pulp.*

2. Also at the trial a parallel demonstration (called the second experiment) was made of the process of the patent in suit, No. 962,678, *with phenol as the agent* (one of the substances specifically mentioned as an example in that patent) and it was admitted that if this were followed by a careful washing of the resulting froth concentrate with warm water and then by a repetition of the process with a pulp consisting of that so washed concentrate and fresh water but without the addition of any more phenol, *no mineral-froth whatever would rise or be formed.* Everything would sink together to the bottom. (R., Vol. I, pp. 398-401; pp. 448, 449, including Q204.) *This negatived the location of any active principle in a coating on the mineral particles.*

A further experiment was described by plaintiff's expert Higgins (R., Vol. I, p. 449, Q210 and p. 450, Q213). In it the process of the patent in suit was again used with phenol as agent. The water of the pulp was filtered from both the resulting froth concentrate and the resulting tailings and was used as pulp water to treat another batch of ore but without the addition of any more phenol. *A full mineral froth rose as at first. This located the active principle in the water of the pulp.* Higgins repeated the experiment with defendant's ore and defendant's agent (alpha-naphthylamine) with the same result.

The facts so demonstrated and proved are not disputed.

They prove to the point of demonstration the fundamental difference between the two processes that in one (patent No.

835,120) the active frothing principle is located in a coating on the mineral particles and in the other (patent No. 962,678) it is located in the water of the pulp.

Speaking of the first and second experiments, Mr. Higgins said (R., Vol. I, p. 448):

> "Q. 204. What do these experiments demonstrate to you or show you?
>
> "A. They show me that in the first experiment, the mineral-frothing agent coats the metalliferous particles and that in the second experiment the mineral-frothing agent does not coat the mineral particles."

What this Court speaks of as the preferential affinity of the agent of patent No. 835,120 for the mineral particles over the gangue is the power of the agent to preferentially coat those mineral particles. Whatever has that power of preferential coating is the agent of patent No. 835,120. Whatever has not that power of preferential coating is not the agent of patent No. 835,120. This is the conception disclosed by the patent No. 835,120 and the definition of that conception given by this Court.

The facts set out above demonstrate that the agent employed in the process of patent No. 962,678 does not come within this definition and conception. It does not coat the mineral particles and so it cannot have that preferential affinity for them that the patent No. 835,120 requires and that this Court emphasized.

The fallacy of the conclusion of the Circuit Court of Appeals in the instant case, as to anticipation by patent No. 835,120, is that it ignores the test by which the user of the process of patent No. 835,120, skilled in the art, would select any agent to be used in place of oleic acid. The use of oleic acid in the minute quantity prescribed is of course clearly and certainly disclosed. No other agent is specifically disclosed by name, but a test is given for selection of other agents and that test determines the extent of the disclosure beyond oleic acid—determines what the public were taught to do by that patent.

What is that test?

It is written all over the patent* and is woven all through the *Hyde* and the *Butte & Superior* decisions of this Court as stated.

That test is whether the agent in the small quantity prescribed will, as oleic acid does, preferentially coat the mineral particles rather than the gangue, "unite mechanically with" the mineral particles as this Court puts it in the *Hyde* case. If it will, it is an equivalent of oleic acid in the process and its use in place of oleic acid will develop the process and be within the broad disclosure of the patent. If it will not, precisely the contrary is the fact.

An agent like phenol known to be wholly soluble in the small quantity prescribed in patent No. 835,120 would under that test be excluded because known by reason of its solubility to be incapable of coating or mechanically uniting with the mineral particles, either preferentially or otherwise, and so incapable of developing the process of that patent. It would be known that it would be wholly incapable of producing the necessary coating of that process.

If the curious minded had purposely disregarded the test clearly laid down in the patent No. 835,120, or the unintelligent had accidentally disregarded it, and employed a soluble agent like phenol in the minute quantity prescribed in patent No. 835,120 and achieved a mineral-bearing froth, he would not have been practicing the process or following the directions or the disclosure of patent No. 835,120. He would have made a true discovery. He would have achieved a new process.

What purposeful disregard of the tests and directions of patent No. 835,120 might discover, or what unintelligent disregard of those tests and directions might accidentally and unwittingly develop in use or lead to, in the way of subsequent discovery, cannot be regarded as any part of the disclosure of patent No. 835,120 under the law. A prior patent is a legal disclosure only of what is clearly and unquestionably and in-

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* The test is stated or adverted to at the following places in patent No. 835,120; p. 1, ll. 33; 37; 41, 42; 54, 55; 95, 96; p. 2, ll. 4; 14; 104; 128, 129; p. 3, ll. 28; 46, 47; 57; 67, 68; 78, 79; 81, 82; 88-90; 98-100; 109-111; 120-123; 125, 126; 129, 130; p. 4, ll. 5, 6; 19; 22; 32-34; 41-43.

evitably added to the knowledge of the world by it (See authorities, *infra,* p. 124).

This Court in the *Butte & Superior* case held pine oil (when used in conjunction with fuel oil and kerosene) to be an agent of patent No. 835,120. Pine oil comes within the prescribed test because it embodies or includes constituent parts that are insoluble and that coat the mineral particles in preference to the gangue. The fact here proved that it is a complex mixture of substances embodying or including also constituent parts that are soluble and that when in solution are themselves mineral-frothing agents (Higgins, R., Vol. I, p. 491, XQ461) was immaterial to the question of infringement of patent No. 835,120 in that case. Pine oil was not named in patent No. 835,120 nor was any similar complex substance containing both kinds of frothing agents, nor was pine oil or any similar complex substance used in any froth flotation process until long after the discovery and invention of the process in issue and long after the issue and publication of the patent No. 962,678, which latter date was June 28, 1910.

The undisputed facts are that from the time of the invention of the process of patent No. 835,120 until after the invention of the process of the patent in suit, the only froth flotation operations were those in Australia with oleic acid on lead-zinc ores, and that the Hyde infringement, using oleic acid on a zinc ore, did not begin until 1911, and that the concentration of porphyry ores by froth flotation did not begin until January, 1913, and then mainly with cresol and thereafter mainly with cheap complex substances containing soluble phenol and cresol as well as insoluble constituents.

The difference between the processes of the two patents is simply expressed in their respective claims.

Claims 1 and 12 of patent No. 835,120 are (R., Vol. II, pp. 1006-7):

> "1. The herein-described proces of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of *an oily liquid having a preferential affinity for metalliferous matter,* (amounting to a fraction of one per cent. on the ore), agitating the

mixture until the *oil-coated mineral matter* forms into a froth, and separating the froth from the remainder by flotation."

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue *by coating the minerals with oil* in water containing a fraction of one per cent. of oil on the ore, agitating the mixture to cause the *oil-coated mineral* to form a froth, and separating the froth from the remainder of the mixture."

Claim 1 of patent No. 962,678 is (R., Vol. II, p. 665):

"1. The hereindescribed process of concentrating ores which consists in mixing the powdered ore with water containing *in solution* a small quantity of a mineral-frothing agent, agitating the mixture to form a froth and separating the froth."

The Circuit Court of Appeals for the First Circuit sought to bridge the chasm between these two processes by resorting to discredited theory and disproved speculation and this in an art in which they were essentially inexperienced and uninformed.

The Circuit Court of Appeals for the First Circuit reached the conclusion that the mineral-frothing agents in solution of patent No. 962,678 really come out of solution at the surfaces of the mineral particles and preferentially coat those mineral particles (although nothing is said about any such action in patent No. 962,678) and are therefore oils or oily substances of patent No. 835,120 under the definition given by this Court —this conclusion being based in part on an assumed application of a so-called "adsorption" theory advanced by defendant's experts.

The Circuit Court of Appeals for the First Circuit reached the further conclusion that the oils or oily substances of patent No. 835,120 (and specifically the oleic acid named in that patent) were really soluble in the water of the pulp to such an extent that their mineral-frothing action in the process was dependent upon that solubility (although nothing is said about any such action in patent No. 835,120).

Thus the Circuit Court of Appeals for the First Circuit, with many other confusing errors and misunderstandings of technical terms and of documents, reached the ultimate conclusion that the process of patent No. 962,678 was none other than the process of patent No. 835,120, carried out with a class of agents well within the four corners of the disclosure of patent No. 835,120.

But the application of the adsorption theory is wholly discredited in the evidence, and it is there shown that the agent in solution of patent No. 962,678 does not coat the mineral particles. We treat this error of the Circuit Court of Appeals for the First Circuit more fully later (*Infra*, pp. 52, 55, 57, 64).

Moreover the assumed solubility of the typical agent, oleic acid, of patent No. 835,120, and the explanation of its mineral-frothing power on the basis of that solubility, is pure speculation and speculation that is disproved in the evidence and shown to be a matter *de minimis*, a negligible matter. The defendant's experts who assert such solubility of oleic acid admit that it is of the same order of magnitude as the solubility of window glass in rain water and one of them (Taggart) further admits (R., Vol. I, p. 211, Q38):

> "glass certainly would not be considered soluble for the purposes of flotation."

We enlarge upon this error later (*Infra*, p. 70).

The Circuit Court of Appeals for the First Circuit urged in support of its conclusion of anticipation that the words "insoluble" and "undissolved" do not occur in patent No. 835,120 as characterizing the mineral-frothing agent of that patent, but the reasoning of the Circuit Court of Appeals for the Third Circuit is more sound and persuasive when it says (244 Fed. at p. 773) as heretofore quoted:

> "The difference between the two patents may be shortly stated to be this: The first process rests upon the use in very small quantity of an oily substance *that does not dissolve in water*, coupled with agitation of the pulp, and this succeeds in producing a special froth that

> is remarkably effective in recovering the minute particles of ore. The second process does not employ *oil, or an undissolvable substance;* on the contrary the 'mineral-frothing agent' must be in solution, *and ex vi termini must therefore be dissolvable.*"

The Circuit Court of Appeals for the First Circuit urges, in support of its conclusion, that two of the agents specified in patent No. 962,678 are known as "oils" in the market, but this does not make them oils of patent No. 835,120 any more than the commercial name "oil of vitriol" for sulphuric acid, makes it an oil of that patent.

The Circuit Court of Appeals for the First Circuit misconstrues certain references in patent No. 835,120 to prior art Cattermole and other patents, as importing into the disclosure of that patent No. 835,120, agents specified in those prior art patents for other purposes and other processes but not specified in patent No. 835,120. We treat of this later (*Infra,* pp. 83-93).

The Circuit Court of Appeals for the First Circuit misconstrues a New Zealand patent by reason of the mere juxtaposition in it (for economy's sake) of the descriptions and claims of the inventions of three United States patents, patent No. 835,120 and two prior Cattermole patents. We treat of this later (*Infra,* pp. 93-99).

The Circuit Court of Appeals in the instant case failed utterly to comprehend that the process of patent No. 835,120, as interpreted and construed by this Court, was a process that depended upon, and acted solely by reason of, the preferential coating of the metalliferous mineral particles with an undissolved oily substance, whereas the process of the patent here in suit, No. 962,678, depends upon, and proceeds by reason of, the modifying of the water of the pulp by a substance which is completely dissolved in that water and does not and cannot "unite mechanically with" the metalliferous mineral particles.

We will, in the detailed discussion of these various matters, consider first the process of the alleged anticipating patent No. 835,120, then the process of the patent in suit No. 962,678, then compare the two, and then point out the errors of the Circuit Court of Appeals for the First Circuit.

SULMAN, PICARD & BALLOT PATENT NO. 835,120

The art prior to this patent, No. 835,120, was well summed up by this Court in *Minerals Separation, Limited* v. *Hyde*, 242 U. S. 261, and the evidence in the case at bar makes substantially no change in the prior art as thus summarized. This Court said (242 U. S. 264, 265):

> "It is clear that in the prior art, as it is developed in this record, it was well known that oil and oily substances had a selective affinity or attraction for, and would unite mechanically with, the minute particles of metal and metallic compounds found in crushed or powdered ores, but would not so unite with the quartz, or rocky non-metallic material, called 'gangue'. Haynes British patent (1860), and United States patents, Everson (1886), Robson (1897) and Elmore (1901). It was also well known that this selective property of oils and oily substances was increased when applied to some ores by the addition of a small amount of acid to the ore and water used in process of concentration. United States patents, Everson (1886), Elmore (1901), and Cattermole (1904).
>
> Prior to the date of the patent in suit [No. 835,120] a number of patents had been granted in this and other countries for processes aiming to make practical use of this property of oil and of oil mixed with acid in the treatment of ores, all of which, speaking broadly, consisted in mixing finely crushed or powdered ore with water and oil, sometimes with acid added, and then in variously treating the mass—'the pulp'—thus formed so as to separate the oil, when it became impregnated or loaded with the metal and metal-bearing particles, from the valueless gangue. From the resulting concentrate the metals were recovered in various ways.
>
> The processes, of this general character, described in the prior patents, may be roughly divided into two classes. The process in the patents of the first class is called in the record the 'Surface Flotation Process,' and it depends for its usefulness on the oil used being sufficient to collect and hold in mechanical suspension the small particles of metal and metalliferous compounds, and by its buoyancy to carry them to the surface of the mixture of

ore, water and oil, thus making it possible, by methods familiar to persons skilled in the art, to float off the concentrate thus obtained into any desired receptacle. The waste material, or gangue, not being affected by the oil, and being heavier than water sinks to the bottom of the containing vessel and may be disposed of as desired.

The process of the other class, called in the record the 'Metal Sinking Process,' reverses the action of the Surface Flotation Process and is illustrated by the Cattermole U. S. Patent, No. 777,273, in which oil is used to the extent of 4% to 6% to 10% of the weight of the metalliferous mineral matter, depending on the character of the ore, for the purpose of agglomerating the oil-coated concentrate into granules heavier than water, so that they will sink to the bottom of the containing vessel, permitting the gangue to be carried away by an upward flowing stream of water."

Patent No. 835,120, issued November 6, 1906, is Defendant's Exhibit 54 (R., Vol. II, pp. 1002-1007).

The invention disclosed utilizes the selective action of oily substances in water for metalliferous mineral particles in preference to gangue in such manner that the metalliferous mineral particles in the ore pulp will be coated with the oily substances and the oil-coated metalliferous particles will become attached to air bubbles and will rise to the surface in the form of a froth which will float upon the surface of the pulp and may be separated from the pulp in any suitable manner, as by overflowing or skimming. It utilizes the preferential affinity of oil for metalliferous matter over gangue in an ore pulp—the action of oil globules diffused or disseminated through an ore pulp in attaching themselves to the metalliferous particles with which they are brought into contact and not attaching themselves to the gangue particles with which they are also brought in contact. Conversely it utilizes the preferential affinity of water for gangue over metalliferous matter and especially over oil-coated metalliferous matter—the action of the water in wetting the gangue particles and persistently covering them and in repelling the oil so that it escapes from the water to the surface of the metalliferous particles and coats the metalliferous particles. Further, in a pulp of oil-

coated metalliferous particles and wetted gangue particles, it utilizes, under agitation, the preferential affinity of air bubbles for these *oil-coated metalliferous particles* over the wetted gangue particles so as to form a *froth of oil-coated metalliferous particles.*

The opening statement of the specification as to the nature and object of the invention broadly defines the substances which are to be used and yet carefully limits them to (Spec., p. 1, lines 13-15):

> "substances which have a preferential affinity for metalliferous matter over gangue."

This preferential affinity must of course be exercised in an ore pulp. It can only be exercised by substances which remain undissolved in the water of the pulp and it results in the coating of the metalliferous matter in preference to the gangue in an ore pulp, as the specification repeatedly states.

The specification first refers to the Cattermole granulation patent No. 777,273 (Spec., p. 1, lines 16-17) for a metal-sinking process, wherein an amount of oil which, as testified to by Mr. Higgins (R., Vol. I, p. 503, XQ563) is about 1.8% on the ore (Spec., p. 1, lines 20-22) or 36 pounds to the short ton of ore,

> "is agitated with an ore pulp, so as to form granules which can be separated from the gangue."

It then refers to the Cattermole, Sulman and Picard patent No. 777,274, wherein, it says (Spec., p. 1, lines 25-27)

> "a similar method of separation is employed, oleic acid being produced *in situ* in the ore pulp."

This method of separation, common to these two Cattermole patents, is separation by sinking the oiled metalliferous mineral particles in granules and flowing off the gangue particles upward in suspension in an up-current of water. Both patents disclose only *metal-sinking processes.*

It will be noted that the reference to these Cattermole patents is not for the purpose of defining the frothing agents to

be used. That has already been defined and limited to "substances which have a preferential affinity for metalliferous matter over gangue" by the statement just preceding.

The reference to the first Cattermole patent is a proper reference to the process which formed the basis for the discovery to be announced in the next paragraph. Its especial reference is to the *amount* of oil used in that process to produce the phenomena of granulation and metal sinking. It was so treated by this Court in the *Hyde* case and in the *Butte & Superior* case.

The other reference is to the soap and granulation patent No. 777,274, and is specifically *confined to the disclosure of oleic acid therein,* and forms the basis for a further statement in the specification of patent No. 835,120 (also specifically confined to the use of oleic acid), viz.: Spec., p. 2, lines 9-13, wherein the method disclosed in that soap and granulation patent of producing *oleic acid in situ* in a pulp (introducing into the pulp soluble oleic soap, disseminating it as soap throughout the pulp, and then decomposing the oleic soap *in situ* by sulphuric acid and thereby forming insoluble oleic acid which will, by reason of its insolubility, be immediately precipitated out of the solution and then will, by reason of its preferential affinity for the metalliferous mineral, coat the metalliferous mineral) is referred to as one method of bringing about the dissemination of oleic acid in the pulp for the purposes of the process of patent No. 835,120.

There is also a reference to the method of recovering the oleic acid from the metalliferous mineral particles after it has coated them and they have been separated from the gangue particles to form the concentrate the separation of which concludes the operation of concentration, to wit, the treatment of the oil-covered concentrate with alkali so as to form oleic soap which by reason of its solubility can be readily washed off the particles for re-use. This recovery of the oleic acid for re-use was worth while in the Cattermole process, which used a minimum of 36 pounds of oleic acid to the ton of ore—and the inventors had been thinking in terms of that process—but it turned out to be not worth while in the froth-flotation process patent No. 835,-

120, where only 2 pounds of oleic acid were used to the ton of ore.

These references to the procedure of the soap and granulation patent in the specification of patent No. 835,120 are as follows (R., Vol. II, p. 1005, Spec., p. 2, lines 3-13):

> "After subsidence the oil-coated metalliferous matter removed as froth is separated from any liquid which may have accompanied it and treated with a dilute solution of caustic alkali, which removes the oleic acid in the form of a solution of soap.
>
> "If desired, the oleic acid used in the first instance may be produced *in situ* in the pulp by decomposing a dilute soap solution with mineral acid, as described in the previous patent, No. 777,274, cited above."

It is to be particularly noted that these references in patent No. 835,120 to the process disclosed in patent No. 777,274 are limited to oleic acid. They merely show that according to what is disclosed in patent No. 777,274 the minute amount of oleic acid which is used in the process of patent No. 835,120 may be formed *in situ* in the pulp by introducing therein soluble oleic soap from which it may be formed by chemical decomposition so as to be precipitated as an undissolved substance in the pulp to preferentially coat the metalliferous mineral particles, and may be recovered from the coated metalliferous mineral particles, after the operation of concentration has been completed (if worth while) by treating them with caustic alkali so as to again form oleic soap which may be washed off the metalliferous mineral particles and used over again in the process.

As to the reference in patent No. 835,120 to Cattermole patent No. 777,273, this, as above noted, was merely a proper reference to the process which formed the basis of the discovery of the process of patent No. 835,120 and to the *quantities* of oil used therein, and was not in any respect a reference to that patent for a disclosure of substances to be used, since it was preceded by a definition of the substances to be used as those having "a preferential affinity for metalliferous matter over gangue" (R., Vol. II, p. 1004; Spec., p. 1, lines 13-15) and was

necessarily limited to substances which in the operation of the process would exercise that preferential affinity.

The errors of the Circuit Court of Appeals for the First Circuit in the inferences drawn from the references in patent No. 835,120 to these two patents, Nos. 777,273 and 777,274, are pointed out at pp. 83, 86, 91-93, 100-106, *infra.*

Any intelligent consideration of patent No. 835,120 and its references to the two prior metal-sinking process patents, above noted, makes it quite clear that the only disclosure in patent No. 835,120 is of a process of froth flotation wherein an undissolved substance is employed which functions by reason of its insolubility, and that the operation of the process is dependent upon the coating by an undissolved substance of the metalliferous mineral particles and what results from that coating.

The discovery of the process of patent No. 835,120 is announced as follows (Spec., p. 1, lines 28-35):

> "We have found that if the proportion of oily substance be considerably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place, and after vigorous agitation there is a tendency for a part of *the oil-coated metalliferous matter* to rise to the surface of the pulp in the form of a froth or scum."

This is an announcement of the discovery that a considerable reduction in the amount of oil in a procedure wherein the pulp is agitated as in the Cattermole granulation process will change that procedure from one of granulation and metal sinking of oil-coated metalliferous matter to one of froth flotation of oil-coated metalliferous matter.

Then follows a number of statements as to preferential features in the process, for example (Spec., p. 1, lines 36-38):

> "Thus the water in which the *oiling* is effected is preferably slightly acidified"

and further (Spec., p. 1, lines 41-44)

> "the effect of this acidity being to *prevent gangue from being coated with oily substance,* or, in other words, to render the *selective action of the oil* more marked."

Another factor, heating, is referred to as follows (Spec., p. 1, lines 51-56):

> "Again, we have discovered that the tendency for the oily substance to disseminate through the pulp and the rapidity with which the *metalliferous matter becomes coated* is increased if the pulp is warmed."

Then there is a statement of the advantage to the process of fine pulverization of the ore (formerly highly objectionable), and then follows the direction as to testing with different ores and different oily substances which was commented upon by this Court (*Infra,* p. 35).

It is to be noted here that this suggestion to test different oily substances with different ores follows all that has been quoted above as to preferential affinity and selective action and the production of oil-coated metalliferous matter, so that it cannot be otherwise interpreted than as a direction to use such oily substances as act by reason of their insolubility in water—such as can be disseminated in an undissolved condition through an ore pulp so as to coat the metalliferous matter, or, in other words, exercise preferential affinity for metalliferous matter over gangue when disseminated through an ore pulp. A metallurgist is taught by this specification throughout that he must coat his metalliferous mineral if he is to carry on the process disclosed, that the oily substance functions in the process solely by coating the metalliferous mineral, and therefore is taught that any substance which completely dissolves when used in such proportions as this patent indicates should be rejected as incapable of carrying on the process here disclosed. And not only is this apparent from the reading of the specification, but it is what in fact happened. That is what the metallurgists of the art were taught and that is what they did prior to the invention here in issue, and the fact is that oleic acid was the only oily substance that was actually used in practice (Higgins, R., Vol. I, p. 512, XQs593, 594) from the installation of the process on a large scale and with highly successful results in Australia, commencing in the year 1905 and continuing down to the date of the invention of the process here

in suit. The use of mineral-froth flotation was limited to these Australian zinc-lead ores and was not extended to other ores until after the invention in issue was made. Defendant has been unable to adduce any evidence that anyone, skillful or ignorant, in testing the application of the process of patent No. 835,120 or in using that process, prior to the second astonishing discovery which resulted in the invention of the patent here in suit, ever used a mineral-frothing agent in solution. There is not the faintest glimmer of a suggestion in this patent No. 835,120 of the use of a mineral-frothing agent in solution or of any possibility of carrying on the froth concentration of ores except by the employment of substances which remain undissolved in the ore pulp and function to preferentially coat the metalliferous mineral particles by reason of the fact that they exist in undissolved condition in the ore pulp.

Then follows an example of the use of oleic acid with a zinc-lead ore, to wit, Broken Hill ore, with sulphuric acid, and the warming of the mixture, and with a brisk agitation (Spec., p. 1, lines 86-88)

> "until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp."

and it is said that when the agitation is stopped the mineral rises in the form of a froth (Spec., p. 1, lines 91-96)

> "which has derived its power of flotation mainly from the inclusion of air-bubbles introduced into the mass by the agitation, such bubbles or air-films adhering only to the mineral particles which are *coated with oleic acid.*"

Then follow directions for the removal of the froth.

The specification also describes (Spec., p. 2, lines 103, 104)

> "an alternative method for the recovery of any sunk *oiled metalliferous matter*"

which is the superaeration or plus-pressure method, and in that description the mineral to which air bubbles are attached to raise them is called "*the oiled mineral*" (Spec., p. 3, line 28).

This superaeration or plus-pressure method or process was divided out from the application for patent No. 835,120 as a

separate invention, and became patent No. 835,479 (Defendant's Exhibit 60, R., Vol. II, pp. 1045-1047).

Claims. The first three claims of patent No. 835,120 are for "an oily liquid having a preferential affinity for metalliferous matter" and point out a procedure wherein the ore pulp is agitated *"until the oil-coated mineral matter forms into a froth."*

The fourth claim is for "an oily substance having a preferential affinity for metalliferous matter" and points out a procedure wherein the ore pulp is agitated *"until the oil-coated mineral matter forms into a froth"* and further specifies "removing the oily coating from the mineral."

Claims 5, 6 and 7 are oleic acid claims and point out a procedure wherein the pulp is agitated "until the oleic acid has been brought *into efficient contact* with the mineral and has formed a froth therewith."

Claim 8 is for the use of "oleic-soap solution" and repeats the language above quoted from claims 5, 6 and 7, and further includes "filtering off the froth and removing the oleic acid therefrom."

Claims 9, 10 and 11 are oil claims and prescribe *"coating the mineral with oil in water."* This language is substantially repeated in claim 12.

Claim 13 is an oleic acid claim and highly specific, and repeats the language which has been quoted from claims 5, 6 and 7 as to bringing the oleic acid into efficient contact with the mineral and the language quoted from claim 8 "filtering off the froth and removing the oleic acid therefrom."

As will be seen, this was a patent for a specific phenomenon, and it was so interpreted by this Court, although it turned out that that specific phenomenon was a matter of very great importance in the art. That specific phenomenon most broadly stated was the coating of mineral particles with an oily substance when the mineral particles were suspended in water in preference to the gangue particles there present and also suspended in the water, the oil being used in such minute amounts as does not cause the oiled mineral particles to adhere to-

gether and form granules but causes the oiled mineral particles to adhere to air bubbles and form a froth.

This Court, in its decision in the *Hyde* case (242 U. S. 261, 265) said as to patent No. 835,120:

> "The process of the patent in suit, as described and practiced, consists in the use of an amount of oil which is 'critical,' and minute as compared with the amount used in prior processes, 'amounting to a fraction of one per cent. on the ore,' and in so impregnating with air the mass of ore and water used, by agitation—'by beating the air into the mass'—as to cause to rise to the surface of the mass, or pulp, a froth, peculiarly coherent and persistent in character, which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal and metalliferous particles of ore which were contained in the mass of crushed ore subjected to treatment. This froth can be removed and the metal recovered by processes with which the patent is not concerned."

and in the *Butte & Superior* case (250 U. S. 336, 345) this Court further said:

> "We held in the former case that the patentees came late into the field of ore concentration investigation, and that their discovery rests upon a prior art so fully developed that it was 'clear from the record that approach was being made slowly, but more and more nearly, to the result which was reached by the patentees of the process in suit in March, 1905,' and that their final step was not a long one.
>
> "Such a patent, in such a field of investigation, must be construed strictly, but candidly and fairly, to give to the patentees the full benefit, but not more, of *the disclosure of their discovery which is to become a part of the public stock of knowledge upon the expiration of the patent period,* and which was the consideration for the grant to them of a patent monopoly.
>
> "With the state of the prior art in mind, we come to consider the nature and extent *of the disclosures* of the patent in suit, but only with respect to the kinds and quantities of oil which may be used in the process."

And in summing up as to the disclosure of patent No. 835,120 this Court further said (p. 349):

> *"the only disclosure* as to the kind and amount of oil which the patentees made to the public as necessary to the practicing of their process is that it must be an oil or oily substance, or oily liquid having a *'preferential affinity for metalliferous matter,'* and that it shall be limited in amount 'to a fraction of one per cent. on the ore'."

SULMAN, GREENWAY & HIGGINS PATENT NO. 962,678, BEING THE PATENT IN SUIT.

The patent in suit No. 962,678, issued June 28, 1910, to Henry Livingstone Sulman, Henry Howard Greenway and Arthur Howard Higgins, is printed at R., Vol. II, pages 663 to 666. It contains, as we believe and submit, the first disclosure of an ore concentration process which proceeds by the operation of a mineral-frothing agent in solution—the first process wherein a soluble mineral-frothing agent dissolved in the water of an ore pulp, and so modifying that water, was utilized to concentrate the ore by mineral-froth flotation.

The patent in suit issued some four years later than the Sulman, Picard and Ballot patent No. 835,120, so fully interpreted and construed by this Court in its two decisions above referred to.

The process of the patent in suit is a departure from, and a discarding of, all the learning of the art as to the repulsion of oil and water and the preference of oil for metalliferous mineral over gangue in the presence of water. Oils, as such, are abandoned. Instead of being built up on the insolubility of oil and similar substances in water, as was practically the whole prior art of ore concentration, including the process of patent No. 835,120, the process of the patent in suit is built up on, and limited to, the solubility of mineral-frothing agents in water. It makes known the astonishing new principle that air bubbles in agitated water that has been *modified by dissolving* certain substances in it can be relied upon (1) to select the metalliferous mineral from the gangue without oil-coating of that mineral, (2) to attach themselves firmly to the so selected metalliferous mineral particles, (3) to float the metalliferous mineral particles to and through the pulp surface and

(4) to form floating upon the surface of the pulp a froth carrying very nearly the whole of the metalliferous content of the ore ready to be overflowed as a product which will constitute a substantial and valuable concentration of the ore.

Sulman, Greenway and Higgins *discovered a new property or force in matter,* namely: the mineral-selecting and mineral-lifting power of air bubbles produced in water modified by the presence of a mineral-frothing agent in solution under the agitation conditions of froth flotation.

It was not a mere discovery of a series of individual frothing agents which in solution and under proper conditions of agitation would develop that mineral-selecting and mineral-lifting force, but it was the discovery broadly of the mineral-selecting and mineral-lifting force of air bubbles produced in water having in solution *soluble mineral-frothing agents generally as a class* under the agitation conditions specified. All mineral-frothing agents in solution will effect the result desired.

As to this particular class of frothing agents—mineral-frothing agents in solution—and as to the newly discovered mineral-selecting and mineral-lifting forces involved, Sulman, Greenway and Higgins *were pioneers.*

The discovery ran counter to all experience and all theory.

It flew in the face of all the teachings of the art.

It broke away from all tradition.*

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* All of the flotation processes of the prior commercial art (with possibly one exception, i.e, Potter-Delprat) depended upon the preferential affinity of the frothing agent for the mineral and the consequent coating of the mineral by the agent, for example, the Elmore bulk oil process, the froth flotation process of 835,120, and the Elmore vacuum process. Moreover the flotation processes of the paper art that never got into commerce similarly depended upon the preferential affinity of the agent for the mineral and the consequent coating of the mineral by the agent, for example, Haynes, Everson, Bessel and many others. This preferential affinity of the agent for the mineral particles and the consequent preferential coating of those mineral particles is pointed out and is emphasized by this Court in *Minerals Separation Ltd.* v. *Hyde,* 242 U. S. 261 and *Minerals Separation Ltd.* v. *Butte & Superior,* 250 U. S. 336.

This preferential affinity of the agent for the metal and the coating of the metal by the agent involves and requires an undissolved or immiscible agent, that is, immiscibility of the agent in the water of the pulp under the conditions of the process.

The Bessel Patents and the Elmore vacuum patents and publications were not before this Court in the cases cited but they both specify the greasing or coating of the metal particles achieved by reason of the preferential affinity of the agent for them, and they both specify or assume insolubility of the agent to that end and these things as a *sine qua non* in each case of the processes disclosed.

The invention was the process proceeding in the flotation cell when such a frothing agent was put in solution in the water of the pulp under conditions of agitation to form a froth, whereby the newly discovered mineral-selecting and mineral-lifting forces in such a froth were developed and utilized.

The process was not the mere mill manipulation but it was as stated what went on in the flotation cell when the pulp and the new reagent were agitated together to form the froth.

That process and invention departed from what had been the very pith and point of the process and invention utilizing undissolved agents of patent No. 835,120.

It violated what had been universally accepted as the *sine qua non* of ore concentration by flotation, namely, the preferential affinity of the frothing agent for the mineral and the consequent coating of the mineral by the frothing agent.

The necessary quality or characteristic of producing when in solution a froth having the newly discovered mineral-selecting and mineral-lifting force *is a class quality or characteristic,* for the class is defined in the claims in issue by that quality or characteristic. *Everything within the terms of those claims will perform the functions required.*

But there are frothing agents which are not mineral-frothing agents. These are exceptions to this rule. The patent gives examples of these exceptions.

The patent also prescribes a simple test to enable the user to determine in any given case what is a mineral-frothing agent of the patent and what is not.

This satisfies the law.

The trial Judge in his opinion, after referring to patent No. 835,120 and the interpretation thereof by this Court, says very accurately (R., Vol. I, p. 619):

> "Into this field, with the process of the first patent [No. 835,120] as a part of the prior art, came the patentee of the second patent,—the patent in suit,—with an undoubted improvement; a process not dependent upon the oily coating of the mineral particles but utilizing a hitherto unknown property of mineral-frothing agents in solution to form air bubbles which attract

> and attach themselves to the uncoated and unoiled mineral particles."

and again (p. 620):

> "But the principle of action,—so far as it is known,—involved in the process in suit, is not the preferential affinity of the frothing agent used for the mineral particles or the coating of those particles, or the attachment of air bubbles to coated particles, as in the first patent, because the frothing agent goes into solution without coating either mineral or gangue, and the law of attraction and attachment of air bubbles to oil-coated mineral particles cannot apply. The process in suit, as it is put by counsel for plaintiff in their brief, 'proceeds by reason of the peculiar character of the air bubbles produced in water modified by the presence of the dissolved mineral-frothing agent employed and by reason of the attraction and attachment of such air bubbles for uncoated metalliferous mineral particles'."

The substances which when dissolved in the water of an ore pulp thus modify the water so as to bring about this selection and attachment and mineral-froth formation by air bubbles, are designated in the patent as mineral-frothing agents in solution. This was a new term in the art, a new classification of substances, classifying them by the newly discovered and theretofore unsuspected capability of imparting to air-bubbles in agitated water, by reason of their being dissolved in the water, these mineral-froth forming qualities. This new class of substances includes substances that are not and cannot by any stretch of the imagination be classed as oils, such as the normally solid substances—camphor (Pltff.'s Ex. 26), benzoic acid (Pltff.'s Ex. 24), alpha naphthylamine (X-cake) (Deft.'s Ex. 116); and the normally liquid substances: lactic acid (Pltff.'s Ex. 25), acetic acid (vinegar) (Higgins, R., pp. 530, 531, RDQs709-712) and alcohol (Sulman patent No. 955,012, R., Vol. II, p. 1060); and also the inorganic mineral-frothing agent in solution, common salt or sodium chloride (Higgins, R., Vol. I, p. 471, Q345). This new class of substances also includes the crystalline solid substance phenol (Pltff.'s Ex. 23) familiar in its weak solutions as the antiseptic known as car-

bolic acid, when used in such small quantity that it is wholly dissolved in the water of the ore pulp. The new class includes also the soluble constituents of some complex substances, one of which known as pine oil, contains several different substances, some of which are soluble and others insoluble (Higgins, R., Vol. I, p. 491, XQ461), but the new class excludes all of the substances therein that are insoluble. It excludes certain soluble substances which promote froth formation, such as "some sugars, dextrine, saponin, albumen, ox gall, etc." (Spec. p. 1, lines 48, 49) but which, as stated in the patent, "in solution will not effect the result described" (*ib.*, lines 47, 48), i. e., will not form a useful mineral-bearing froth.

In the process of the patent in suit the mineral-frothing agent goes into solution and does not coat the metalliferous mineral particles. It modifies the water and causes the production in the modified water (for one thing) of a fineness of bubbles and a great increase in the number of bubbles as compared with the insoluble mineral-frothing agents theretofore known and (for another thing) bubbles having a greater ease of attachment to mineral particles. Mr. Higgins testified as follows (R., Vol. I, pp. 473, 474):

> "Q. 356. Now, will you compare the process of air-froth flotation as carried on with insoluble mineral-frothing agents, with the process of air-froth flotation as carried on with soluble mineral-frothing agents?
>
> A. In the use of the air-froth flotation process with an insoluble mineral-frothing agent, the mineral-frothing agent coats the metalliferous particles, whereas, in the use of the air-froth flotation process with the soluble mineral-frothing agent, the mineral-frothing agent does not coat the metalliferous particles, but goes into solution. In the case of the soluble mineral-frothing agent, there is a great increase in the number of bubbles which are formed by the same kind of agitation. They are sensibly smaller than in the use of an insoluble mineral-frothing agent. I think those are the major differences."

And further (p. 476):

> "Q372. Now, in the process of air-froth flotation employing soluble frothing-agents, what, in your opinion, does the soluble frothing-agent do in the process?

A. It forms or assists in the formation of a very large number of minute bubbles which attach themselves to the mineral particles.

The Court: Is that the purpose of that frothing agent to produce more bubbles?

The Witness: Yes, sir, it produces more bubbles of such nature that they have a greater ease of attachment to the mineral particles."

The specification opens with a general statement of the nature and objects of the invention (p. 1, lines 9-14), which needs no comment. This is followed by a very full statement of practices according to the invention (p. 1, lines 15-52), then by an example of one method of carrying the invention into effect (p. 1, lines 53-78), and then by a reference to the drawings, which show one form of apparatus for use in the process (p. 1, lines 79-83), and a particular description of the operation of the process as carried on in this apparatus (p. 1, line 84; p. 2, line 16). This completes the disclosure.

Then follow references to prior patents and processes and statements pointing out the novel features of the invention (p. 2, lines 17-67), and then a disclaimer (p. 2, lines 68-77).

The statement of practices according to the invention is, like other parts of the disclosure, for the information of those skilled in the art, so as to enable them to use the invention. In order that the information afforded may be accurate such a statement should, of course, be founded upon the actual investigations of the inventors and should not go beyond the knowledge which the inventors actually possess at the time of preparing their specification. And we find in this paragraph an excellent summary of investigations covering a wide field, highly informative of the nature of the invention and fully justifying the broad claims which appear, as they should, at the end of the specification. Such a statement does not usurp the functions of the claims, but should be, as it is, helpful in arriving at the true meaning of the claims. For example the term "mineral-frothing agent" qualified by the words "in solution," which appears in the claims, is here defined as one or

more substances which in solution enable metallic sulphides to float under conditions of agitation such that the ore particles suspended in a liquid such as water come in contact with a gas and the metallic sulphide particles float to the surface in the form of a froth which can be separated by well known means. Then follows this statement, naming certain substances, which have been found to be included within this term (Spec. p. 1, lines 30-35):

> "Among the organic substances which in solution we have found suitable for use as mineral-frothing agents with certain ores are amyl acetate and other esters; phenol and its homologues; benzoic, valerianic and lactic acids; acetones and other ketones such as camphor."

This it will be noted is the naming of a number of substances *which have been found suitable,* but these substances are not even said to be all that have been found suitable, and many substances are named by classes, such as esters, phenol homologues and ketones. This statement gives to the skilled metallurgist knowledge of the researches of the inventors. It is plainly well within what the inventors have actually determined by test. The statement is of what the inventors have found to be true.

It is then suggested that results are sometimes improved with the use of two or more of these mineral-frothing agents in admixture, and then comes the statement (p. 1, lines 39-45):

> "The above mentioned mineral-frothing agents are all more or less effective in the presence of an acid such as sulphuric acid and are given as types but are not intended to form an exhaustive list of suitable organic substances which may be used in this manner and for these objects."

Thus we learn that the mentioned substances which have been found to be effective with certain ores, have, *with these certain ores,* been found to be effective in the presence of such an acid as sulphuric acid, but we are further informed that these substances which have been so found to be effective with

an acid are merely given as types and are not intended to form an exhaustive list of substances or even of organic substances which may be used in processes embodying the invention. These disclosures of what the inventors have found to be facts in relation to their invention, of procedures that they have tested and found to be in accordance with their invention, accompanied by the statement that these substances are given as types or examples and not as a full or exhaustive list of what they have defined as mineral-frothing agents, are entirely consistent with the broad claims in issue, and are in compliance with the law as to disclosures in a specification.

Then follows the statement (p. 1, lines 46-52):

> "On the other hand there are many organic compounds which in solution will not effect the result described, such as some sugars, dextrin, saponin, albumen, ox gall, etc., and a simple test is required in the case of varying ores or materials to determine which organic compound is most suitable."

The statement here given as to soluble organic substances which are not mineral-frothing agents has been heretofore commented upon.

As to the requirement of tests with varying ores and varying mineral-frothing agents, the inventors here state the necessary and usual procedure of metallurgists, and their disclosure as a whole is as definite and as precise as under the circumstances of the case it was reasonably possible for them to make it. A similar disclosure in patent No. 835,120, although it named "oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue" (Spec. 835,120, p. 1, lines 12-15; Vol. II, p. 1004) gave but a single example, oleic acid, and then said (*ib.* Lines 61-79):

> "The proportion of mineral which floats in the form of froth varies considerably with different ores and with *different oily substances,* and before utilizing the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine

> *which oily substance* yields the proportion of froth or scum desired."

As to this disclosure this Court said in *Minerals Separation, Ltd.* v. *Hyde,* 242 U. S. 261, at 270, 271:

> "Equally untenable is the claim that the patent is invalid for the reason that the evidence shows that when different ores are treated preliminary tests must be made to determine the amount of oil and the extent of agitation necessary in order to obtain the best results. Such variation of treatment must be within the scope of the claims, and the certainty which the law requires in patents is not greater than is reasonable, having regard to their subject-matter. The composition of ores varies infinitely, each one presenting its special problem, and it is obviously impossible to specify in a patent the precise treatment which would be most successful and economical in each case. The process is one for dealing with a large class of substances and the range of treatment within the terms of the claims, while leaving something to the skill of persons applying the invention, is clearly sufficiently definite to guide those skilled in the art to its successful application, as the evidence abundantly shows. This satisfies the law. *Mowry* v. *Whitney,* 14 Wall, 620; *Ives* v. *Hamilton,* 92 U. S. 426, and *Carnegie Steel Co.* v. *Cambria Iron Co.,* 185 U. S. 403, 436, 437."

As stated by this Court the essential thing as to variations of treatment is that they *"must be within the scope of the claims,"* and this being so, "the range of treatment *within the terms of the claims* * * * is clearly sufficiently definite to guide those skilled in the art to its successful application" and "satisfies the law."

The decision of this Court upon a similar set of circumstances is a complete answer to all of defendant's attacks upon the certainty of the disclosure of the patent in suit, upon the omission from that disclosure of the specific organic soluble mineral-frothing agent which the defendant uses, and upon the fact that the patent does not affirmatively say that certain soluble mineral-frothing agents with certain ores may be employed in neutral or alkaline pulps in procedures embodying

the invention claimed. Any procedure "within the scope of the claims" or "within the terms of the claims" is within the scope of the patent and is an infringement.

The function of the disclosure of a specification is to assist in the understanding of the claims, and when therefore we find, as in the claims of the patent in suit, the expression "agitating the mixture to form a froth," we may look to the specification to assist us in understanding just what is meant by this simple language. It may be noted, however, that the language of the claims is so simple, direct and complete that we are really only concerned with the consistency of the claims with the disclosure.

The specification says (p. 1, lines 22-29)

> "the mixture is thoroughly agitated; a gas is liberated in, generated in, or effectively introduced into the mixture and the ore particles come *in contact with the gas* and the result is that *metallic sulphide particles float to the surface in the form of a froth or scum.*"

Obviously agitation to form a froth requires the presence in the ore pulp of such bubbles of air or other gas as will form a froth, and agitation to form a froth in "a process of concentrating ores" is such agitation as will form that kind of a froth which on separation will effect a concentration of the ore. The claim does not prescribe the manner in which these air or other gas bubbles shall be introduced into the ore pulp, and so there is no limitation in the scope of the claims as to the manner of the introduction of these bubbles, but the specification by way of disclosure says that a gas may be "liberated in" the pulp, (as by reduction of pressure which will cause air to escape from solution and form bubbles in the pulp), or may be "generated in" the pulp (as by chemical action generating a gas in the pulp), or may be "effectively introduced into" the pulp (as by blowing air into the pulp through a porous medium as defendant does). The skilled metallurgist to whom the specification is addressed is thus given a wide range of instruction as to the method of bringing about that necessary intro-

duction of bubbles of air or other gas into the ore pulp which will develop the selective action of the air or gas bubbles for the sulphide particles in the pulp and the formation of a mineral-bearing ore-concentrating froth. It should be noted that in the practical work of the art, air is the only gas used. It costs nothing except the cost of the power required to draw it into the pulp or to compress it and blow it into the pulp.

The example of one method of carrying the invention into effect is, of course, merely an example, but it is characterized by such minute and specific description as is necessary to assure that the skilled metallurgist may precisely follow it in order to exactly repeat it. It is suggested that "the tailings can be retreated by the same process" (Spec. p. 1, lines 73, 74), as defendant does, and that this may be done "with or without the addition of fresh quantities of the organic materials referred to" (Spec. p. 1, lines 74-76) (and defendant retreats without the addition of fresh quantities of soluble mineral-frothing agent) and that "The action may in some instances be improved by heating the mixture" (Spec., p. 1, lines 76-78). The latter suggestion justifies claim 8, which includes heating the mixture as an essential element and which is the only claim so limited.

Since the apparatus shown is stated to form no part of the invention (Spec., p. 1, lines 82, 83) and no question is raised as to the accuracy of the description of the operation of this apparatus and the carrying on of the process therein, there is no occasion for commenting upon this quite full description.

Claims. The invention of the patent in suit is well summed up in the claims. The claims in issue, stated analytically, without alteration in words or punctuation, are as follows:

1. The herein described process of concentrating ores which consists in

(a) mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent,

(b) agitating the mixture to form a froth and

(c) separating the froth.

2. The herein described process of concentrating ores which consists in

(a) mixing the powdered ore with water containing in solution a small quantity of an organic mineral-frothing agent,

(b) agitating the mixture to form a froth and

(c) separating the froth.

The only difference between claims 1 and 2 is that in place of "a mineral-frothing agent" as specified in claim 1, claim 2 specifies "an organic mineral-frothing agent." Thus claim 2 does not cover a process employing an inorganic mineral-frothing agent in solution, such as common salt or sodium chloride, whereas claim 1 does.

Common salt (sodium chloride) is a soluble mineral-frothing agent with copper ores (Higgins, R., Vol. I, pp. 470, 471, Qs339, 340, 344; p. 472, Q348), and as it is an inorganic substance, a process employing it in solution is covered by claim 1 and not covered by claim 2. Sulphuric acid under certain conditions with one particular ore acts in solution as a mineral-frothing agent and is also an inorganic substance (Higgins, R., Vol. I, p. 471, Q345). A process thus using it would be covered by claim 1 and not by claim 2.

It is to be noted that the claims are not for *substances* but are for *processes*. The carefully selected terminology of the patent, both in the descriptive parts of the specification and in the claims, limits the scope of the patent to froth-flotation *processes involving the use of mineral-frothing agents in solution,* and by the descriptive part of the specification we are instructed as to the manner in which it may be determined whether a given soluble substance is capable or incapable of use in the process as a mineral-frothing agent, and we are warned that certain soluble substances, and moreover substances which when dissolved in water tend to promote froth formation, are not capable of acting as mineral-frothing agents. Claim 1 therefore includes within its scope froth-flotation *processes* involving the use of any and every soluble substance

which in solution acts as a mineral-frothing agent, and claim 2 every such process wherein such substance is an organic substance. These claims exclude from the subject matter patented by them all processes employing substances which do not dissolve and all processes employing substances which do dissolve unless such substances act in the process as mineral-frothing agents in solution.

The disclosure upon which is based this *wholly new classification of substances* and which first announced to the world this *wholly new and remarkable process*, comes well within the statute requiring an inventor to "file in the Patent Office a written description of" "his invention or discovery" "and of the manner and process of * * * using it, in such full, clear, concise and exact terms as to enable any person skilled in the art or science to which it appertains * * * to * * * use the same" (U. S. R. S. 4888); and this disclosure is followed by claims which "particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery" as required by the same statute.

Comparison of the Process of Patent No. 835,120 with the Process of the Patent in Suit, No. 962,678.

Generally comparing the process of the patent in suit with that of the first patent, No. 835,120, it is a fact that the only essential change in the things that are put into the pulp in the process of the patent in suit is that the agent is one which will go into solution in the water of the pulp instead of remaining undissolved therein. It is a fact that the same machines may be used in the process of the patent in suit as are used in the process of patent No. 835,120, and that the machines operate, as machines, in the same manner. But the process of patent No. 835,120 utilizes the well known quality of oil of coating or greasing the mineral and repelling the water; whereas the process of the patent in suit discards that idea and introduces an entirely new idea, viz., *modifying the qualities of the water itself*. Therefore it is obvious that the process of the patent in suit cannot be an improvement of the process of patent No.

835,120. Expressed in the language of the patent law, patent No. 835,120 does not in any manner dominate the invention in issue. No relation of genus and species exists. It is not the fact that any one practicing the process of the later invention would thereby infringe any claim of the earlier patent, and this is always the case where a later invention is an improvement of the earlier. The later invention here in issue is not an improvement of the earlier but a complete departure from it. The two inventions are distinct, the one (that of patent No. 835,120) utilizing the old and well known preferential affinity of oil for mineral over gangue, and the other (that of the patent in suit) departing altogether therefrom and entering upon and opening up a new and theretofore undiscovered field of invention. The invention in issue is a *pioneer invention. It utilizes for the first time dissolved substances as mineral-frothing agents with a new mode of operation thereby effected.*

The following comparison epitomizes the facts heretofore discussed.

The known physical differences between the operations of the two processes are as follows:

1. The process of 835,120 utilizes a minute amount of a water-repelling oil as a mineral-frothing agent and the preferential affinity of that oil for metalliferous mineral over gangue in an ore pulp, and in it the oil is *not dissolved* but is broken up into minute globules suspended in the water of the pulp which are disseminated throughout the water of the pulp so that they come in contact with the metalliferous mineral particles also suspended in the water of the pulp and coat these particles with a thin film of oil.

In the process of 962,678 a soluble mineral-frothing agent is *dissolved* in the water of the pulp; this agent does not and cannot exert preferential affinity for the metalliferous mineral over the gangue or coat the metalliferous mineral particles. It stays in solution in the water of the pulp throughout the whole operation of the process and acts to modify the water of the pulp.

2. In the process of 835,120 the oil-coated metalliferous mineral particles become attached to air bubbles which lift the oil-coated metalliferous mineral particles up through and out of the pulp and form upon the surface of the pulp a froth of oil-coated metalliferous mineral particles attached to bubble films.

In the process of 962,678 the water of the ore pulp is now a solution, and in this solution the uncoated metalliferous mineral particles are suspended. A much greater number of air bubbles forms in this solution including a multitude of much finer bubbles, and these air bubbles attach themselves to the uncoated metalliferous mineral particles and lift them up through and out of the pulp and form upon the surface of the pulp a froth of uncoated metalliferous mineral particles attached to bubble-films, the liquid in these films being a part of the solution in which the bubbles were formed.

3. In the process of 835,120, after the formation of the froth, practically all of the oil is in the froth as a coating upon the metalliferous mineral particles therein. In the impoverished pulp below there is practically only gangue and water. Of course the process is not perfect, and there is a trace of oil-coated metalliferous mineral left in the impoverished pulp.

In the process of 962,678 after the formation of the froth practically all of the dissolved mineral-frothing agent remains in the impoverished pulp. Only so much thereof is in the froth as is dissolved in the water of the films of the bubbles of the froth. The trace of metalliferous mineral that remains in the impoverished pulp in no degree adds to the amount of mineral-frothing agent in the pulp.

4. In the process of 835,120 after the froth has been removed it can be broken down and washed with water, but this merely sets apart the oil-coated metalliferous mineral particles from the gangue entrapped in the froth. Notwithstanding the washing with water the oil coating stays on the metalliferous mineral particles, and if these particles are washed and filtered

and then put back into fresh water and agitated and aerated the presence of the oil coating on the particles will reveal itself by causing formation again of a mineral-bearing froth with substantially the same recovery of metalliferous mineral particles in the froth as in the first operation. On the other hand the impoverished pulp is impotent to form again a mineral-bearing froth, and if fresh ore is added to it, with agitation and aeration, no froth will be formed.

In the process of 962,678 after the froth has been removed, if it be washed with water in the same way and filtered and then put back into fresh water and agitated and aerated, it is incapable of again forming a mineral-bearing froth. The water of the impoverished pulp on the other hand contains the dissolved mineral-frothing agent and may be used over again with fresh ore and without the addition of any mineral-frothing agent; and if the water of the films of the froth and the water of the impoverished pulp are separated and used with fresh ore and no added mineral-frothing agent, they will produce again, upon agitation and aeration, a mineral-bearing froth concentrate of substantially the same metalliferous mineral content as the first froth.

Additionally to the physical differences above enumerated the bubbles of the process of 962,678 have a greater ease of attachment to the metalliferous mineral particles, and the froth of the process of 962,678 is more copious and less persistent and does not so well carry oversized metalliferous mineral particles as the froth of the process of 835,120.

Both inventions are what are termed empirical inventions. That is to say, they were not the result of *a priori* reasoning. Rather they were stumbled upon in the course of extensive experimental investigations. They followed unexpected discoveries, true discoveries of theretofore unknown phenomena. They cannot even now be explained and from this it follows that they could not have been predicted. We do not know today why the physical forces act as they do. We only know that as a result of the action of the physical forces involved in the two different

processes different phenomena occur and different operations take place and different results are obtained.

And notwithstanding the magnitude of the interests at stake both in the use of these processes and in the efforts to destroy the patents for these processes, notwithstanding the researches of scientists and metallurgists the world over, the plaintiff and defendant came to this trial, at this late date, utterly unable to put forward satisfactory theories of the operation of the two processes. So far as the plaintiff is concerned, its witnesses faced that fact and frankly admitted it (Higgins, R., p. 476, Q372 and Court's questions; Chapman, pp. 559, 560, Q162). Defendant's witnesses put forward partial theories, which, as we show, are contradicted by facts, and Dr. Bacon frankly tells us how little the scientist relies upon theories of that character. He says (R., p. 343, Q16):

> "I might say that investigators, as they go along usually get what we call theories, and the theory is sometimes useful to tie up to, and as soon as the facts don't tie up any more, then it is discarded and we get another theory. But at that time we were working on a theory that electrical forces were the forces, perhaps, which came into play and which caused flotation. We thought at that time that we had some evidence for that."

Since we cannot explain the actions of the physical forces which take place in froth-flotation processes, whether that of patent 835,120 or that of 962,678, no complete detailed comparison of them can be made. Therefore we should accept other evidence in addition to that of the things apparent to the eye or capable of being shown by demonstration, as establishing the fact that the processes are substantially different. Such evidence is afforded by the fact that the process of the patent in suit (either alone or conjointly with the process of patent No. 835,120) has solved the problem of the concentration of that great body of American copper ores known as the porphyries, while the process of patent No. 835,120, when not conjointly used with the process of the patent in suit, failed to solve that problem. We should also accept the fact that all suc-

cessful commercial air-froth flotation operations of today utilize the process of the patent in suit (either alone or conjointly with the process of patent No. 835,120), whereas before it was invented and when the process of patent No. 835,120 alone was known and used, the successful operations of air-froth flotation ore concentration were confined to those carried on in Australia with zinc-lead ores. These outstanding, practically undisputed facts, it is submitted, conclusively demonstrate that the mode of operation of the process of patent No. 835,120 and the mode of operation of the process of the patent in suit must be and necessarily are different. We do not know, and it is not at all necessary that we should know, why this is so. As was said by this Court in *Diamond Rubber Co.* v. *Consolidated Rubber Tire Co.*, 220 U. S. 428, at pp. 435, 436:

> "A patentee may be baldly empirical, seeing nothing beyond his experiments and the result; yet if he has added a new and valuable article to the world's utilities, he is entitled to the rank and protection of an inventor. And how can it take from his merit that he may not know all of the forces which he has brought into operation? It is certainly not necessary that he understand or be able to state the scientific principles underlying his invention, and it is immaterial whether he can stand a successful examination as to the speculative ideas involved."

The crux of the question of patentable novelty in the process of the patent in suit is whether or not it merely uses an equivalent for the undissolved mineral-frothing agents prescribed in patent No. 835,120 in the process of that patent and thereupon merely achieves the same result by the same mode of operation. In approaching this question care must be taken not to confuse what is meant by the mode of operation of a process. It does not mean machinery or the mode of operation of machinery. It does not mean mill manipulation. It does mean the way in which the result is accomplished by the use of the prescribed process. Therefore when we speak of the process of patent No. 835,120 and the process of the patent in suit and the differences between them, we mean differences with respect to the mode of operation of the processes and by

that we mean differences which proceed in the pulp and in the froth whereby the result sought is achieved, and we do not mean the machinery used or the mill manipulation. Therefore it does not clarify the matter at all to say that the mode of operation is the same because the same machines mechanically operated in the same manner and subjected to the same mill manipulation may be utilized in carrying out the two processes, nor does it clarify the matter to say that a mineral-bearing froth is achieved in each case.

Using the term properly, the inquiry should be: Is the mode of operation, the law or principle of action, which proceeds in the process of the patent in suit the same as the mode of operation, the law or principle of action, which proceeds in the process of patent No. 835,120? We submit that the evidence as to the manifest physical differences and as to the differences that are shown by demonstrations and as to the differences in the practical results achieved establish beyond peradventure that the modes of operation of the two processes, the laws or principles of action by which they proceed, are and must be substantially and fundamentally different.

It may be stated that the actions of the physical forces which take place in the pulp and in the froth are unknown, and it is impossible to give the reason why in the process of patent No. 835,120 the oil selectively coats the metalliferous mineral particles and the air bubbles selectively attach themselves to the oil-coated metalliferous mineral particles and form a persistent mineral-bearing froth, and why in the process of the patent in suit, the water, modified by the mineral-frothing agent dissolved in it, causes the production of a much greater number of finer bubbles which selectively attach themselves and even with greater ease to the uncoated metalliferous mineral particles and form a more copious but less persistent mineral-bearing froth. Since we do not know in full detail what takes place in either process or why it takes place, we may well consider the differences in what the two processes will do. The fact therefore that the invention of the patent in suit solved the problem of the froth-flotation concentration of the great

body of copper ores and that the process of patent No. 835,120 failed alone to do this is, we submit, convincing evidence of a very substantial and a very practical and a very highly useful difference between the two processes.

Commercial Operations of Mineral-Froth Flotation Before and After the Invention of the Patent in Suit, No. 962,678.

Commercial operation under patent No. 835,120 began in Australia in 1905 (R., Vol. I, p. 551, Q77). The operations were large, including six plants (Q79) and were highly successful financially (R., Vol. I, p 554, Court's question). The great dumps of Australia, the reject of water concentration (Higgins, R., Vol. I, p. 459, XQs269-271) were exclusively treated by one of the plants and four of them treated both dumps and current tailings of water concentration (Chapman, R., Vol. I, p. 553, Q91). In all the plants oleic acid was used in the proportion of 1½ to 2 pounds per long ton of ore (pp. 551, 552, Qs80-82). These were the conditions when Mr. Chapman left Australia about June, 1908 (p. 551, Q78). Mr. Higgins left England for Australia in August, 1908, and stayed in Australia until about March 10, 1909 (R., Vol. I, Stipulation, p. 600, first paragraph) and thus carries the story of Australian operations beyond February 1, 1909, the record date of the invention in issue. His description of the operations as then carried on in Australia (R., Vol. I, p. 459, Qs264-269) is a description of the practical use of the process of patent No. 835,120—the practical use of the froth-flotation process—at about the time that the specification of the patent in suit was written. Oleic acid was the only mineral-frothing agent used and sulphuric acid was used with it as a gangue-corrective.

Then in 1908 and 1909 the invention in suit was made and in 1910 patent No. 962,678 issued.

The next reference in the evidence to practical operations of froth flotation is that at the Saxbergets Mine in Sweden in or about July, 1912 (Chapman, R., Vol. I, p. 561, Qs175, 176). The metallurgical art had then been enriched by the knowledge of the invention of the patent in suit, so that it was then a known

fact that soluble substances could be used as mineral-frothing agents. Mr. Chapman selected a local wood-tar which had a soluble as well as an insoluble mineral-frothing constituent. In testing it he followed the instructions of patent No. 835,120 and the instructions of the patent in suit. The plant was operated with this local wood-tar and thereby conjointly carried on the process of patent No. 835,120, and the process of the patent in suit. This has been referred to by defendant's counsel as a striking example of what a metallurgist would do if he had only patent No. 835,120 before him, whereas the fact is that Mr. Chapman had knowledge both of that patent and of the patent in suit when he selected and used this local wood-tar.

Infringement in the *Hyde* case began late in 1911 and had to do with zinc ores with oleic acid as the agent. The infringement in the *Butte & Superior* case followed that in the *Hyde* case with the same ore and involved the conjoint use of the process of the patent in suit and of the process of patent No. 835,120.

The great use of the invention of the patent in suit, No. 962,678, has been with porphyry copper ores. That invention solved the problem of the froth-flotation concentration of copper ores generally and particularly of porphyry copper. George A. Chapman, whose experience in practical work of the froth-flotation process has extended over the past 23 years (R., Vol. I, p. 551, Q73) and who has installed this process in many places the world over (Q74) testifies that in all his experience in froth-flotation he has never known of any instance where porphyry ores have been successfully treated with an insoluble mineral-frothing agent alone (R., Vol. I, p. 560, Qs164, 165) and that a wholly soluble or a partly soluble mineral-frothing agent has always been used (Q165). He briefly outlines the story of the first installation and use of the froth-flotation process on porphyry ores, this being at the Inspiration Mine, Arizona, in January, 1913, mainly with cresol as the mineral-frothing agent (R., Vol. I, pp. 554, 555, Qs98, 107). This soluble mineral-frothing agent cresol is a homologue of phenol (Taggart, R., Vol. I, p. 240, Q109) and therefore included within the homologues of phenol named in the patent in suit (Specification,

p. 1, line 34). These successful operations brought about the installation of a larger test plant, and eventually of a large mill with a capacity of treating from 16,000 to 18,000 tons per day (R., Vol. I, p. 555, Qs107-110). It may be noted that the final types of apparatus used at this great mill were pneumatic machines, partly of the standard Callow type, such as defendant here uses, and partly what is known as the Inspiration cell, which also has a porous canvas bottom and is of the same general type as the Callow cell (R., Vol. I, p. 556, Qs121-124).

All of this work at the Inspiration Consolidated Copper Company has been under license from plaintiff and its predecessors since April 10, 1913 (Pltff.'s Ex. 18, Stipulated Roberts' Affidavit, R., Vol. II, p. 717), a few months after the first test plant was installed. It will be noted that this was the first license granted to a porphyry company. It will be noted also that the total treatment of that porphyry ore at that mine has amounted to 30,303,675 tons (R., Vol. II, p. 723).

The soluble mineral-frothing agent cresol was first used in these successful operations. This led to a search for cheap sources of cresol, and such cheap sources were found in the cheap coal-tar and wood-tar products which can be manufactured so as to contain in sufficient quantities cresol, phenol and their homologues. These substances also contain insoluble oils which were found to assist in the operations. Hence followed the conjoint use of the process of the patent in suit and of the process of patent No. 835,120.

Confirmatory of the difficulty of the problem of concentrating porphyry ores by flotation, defendant proved that on July 1, 1914 (Bacon, R., Vol. I, p. 339, Q6), eighteen months after the commencement of the work at Inspiration, a research Fellowship was founded at the Mellon Institute of Industrial Research in Pittsburgh, and that those who founded the Fellowship advised the Institute (Bacon, R., Vol. I, pp. 339, 340, Q7):

> "that while flotation had been started in this country on certain types of ores, particularly zinc ores, that it was not possible to float the great body of ores in this country, that is particularly the copper ores."

Again he says that virtually all of the work of research was with copper ores "because we were trying to float the hard ones" (p. 344, Q18). He also admits in cross-examination that he was advised of what was being done at the Inspiration mine in treating porphyry ores by flotation and says that it was not the impossibility of flotation of copper ores that he referred to but the impossibility of doing it profitably (pp. 350, 351, XQ46). Obviously no problem in the metallurgical art is solved until the operation can be carried on profitably.

Another remarkable example of the use of the process of the patent in suit is at the Anaconda mine in Montana. Here the copper license is dated February 1, 1915 (R., Vol. II, p. 714) and Mr. Chapman spent some two or three years in installing the plant (R., Vol. I, p. 557, Qs138, 140). This plant has a capacity in copper ore of treating between 11,000 and 12,000 tons a day by flotation (Qs141-143). A zinc license was also taken out on February 14, 1918, and a zinc mill installed with a capacity of treating about 2,000 tons of ore per day (R., Vol. I, p. 558, Qs144, 149). The returns of this Company show that under these licenses 20,305,726 tons of copper ore have been treated (R., Vol. II, p. 723) and 1,649,617 tons of zinc ore (p. 722).

Another remarkable feature of these great mills was the utilization of the soluble mineral-frothing agent kerosene acid sludge, which was a waste product before it was used in flotation (R., Vol. II, p. 558, Qs150, 152). This it will be noted is given as one of the principal reagents used by the Anaconda Company both for copper ores and zinc ores (R., Vol. II, p. 696).

Among the other licensees whose tonnage treated exceeds 1,000,000 are the Phelps Dodge Corporation, whose license is dated December 31, 1917 (R., Vol. II, p. 718) and who have treated 1,980,566 tons of porphyry ores (Pltff.'s Ex. B, p. 93) under its license, and the Engels Copper Mining Company, whose license is dated June 18, 1914 (p. 716) and who have treated 1,892,036 tons of ore under their license (p. 722). Several other licensees have treated under license amounts in the neighborhood of a million tons.

But the general recognition of plaintiff's patent in suit came slowly and only after extensive litigation. Among the porphyries the Utah Copper Company, Ray Consolidated Copper Company, Chino Copper Company and Nevada Consolidated Copper Company took out licenses as of January 1, 1922, and their combined tonnage treated, both that before they were licensed and that under license since their recognition of the patent, amounts to 86,070,722 tons (R., Vol. II, p. 723). In this class of mining companies who litigated first and then settled is included the Miami Copper Company, whose license is as of January 1, 1922, and whose aggregate tonnage, both before and after the license, is 13,133,998 (*ib.*).

The Butte & Superior Mining Company is another of the mines which litigated for years and then took a license. It has a zinc license and a copper license, both as of January 1, 1922 (R., Vol. II, p. 715) and its total tonnage treated is 2,979,585 (R., Vol. II, p. 723).

These individual figures are sufficiently large to show the tremendous use of the invention, and it may be noted, as appears from the list of reagents (R., Vol. II, p. 712) that soluble mineral-frothing agents are present in all of these operations even where zinc ores are treated.

By reason of the variant methods in which the 144 licensees in the United States of the plaintiff have made their returns, it is impossible to give the aggregate figure of the tonnage of ore treated which has paid tribute to the patent in suit. The total tonnage, however, of those licensees whose returns are of tons of ore treated has been about 170,000,000 (R., Vol. II, p. 725) and where the returns were in concentrates produced the tons of concentrates thus produced were more than a million tons, and where the returns were in the weights of metals recovered the aggregate was nearly 240,000,000 pounds of lead, zinc, copper, gold and silver recovered. These colossal operations were made possible only by the invention of the process of the patent in suit. This fact justifies liberal treatment of the patent on the issues both of validity and scope (*Infra,* pp. 122, 123).

In these practical operations the use of acidified pulps has not played a large part. The reagents used by 80 of the 144 licensees of the plaintiff are given (R., Vol. II, pp. 696-712) and only seven of them acidify their pulps, in each case with sulphuric acid. These include Anaconda (p. 696), Butte & Superior (p. 699), Elm Orlu, for its zinc ore and not for its copper ore (p. 702), Utah Copper Co. (p. 711) and three smaller concerns (pp. 700, 705, 707). This acidification of ore pulps, first disclosed in the patent to Everson No. 348,157 of 1886, forty-three years ago, and standard in the practical art at the time of the invention in issue, like the heating of pulps referred to by Professor Bacon (R., Vol. I, p. 347, Qs33-35), has been largely done away with in the development of the art and the extension of the use of the process in suit to *very many different ores*. The Australian operations of the froth-flotation process used sulphuric acid (Higgins, R., Vol. I, p. 459, Q267), and great litigations were fought in England and Australia wherein the owners of the Elmore patents for a bulk-oil or oil-buoyancy process employing an acidified pulp, endeavored to establish the fact that the use of sulphuric acid in the froth-flotation operations employing oleic acid as the oil, was an infringement of the corresponding Elmore British patent No. 6519 of 1901 (25 R. P. C. 743, 744) and Elmore Australian patent No. 11,307 of 1901 (31 R. P. C. 210-212), both patents being essentially for the use of acid to enhance or promote the selective action of oil in an ore-concentration process. It was also suggested in the early disclosures of the art that alkalies could be used to enhance or promote selectivity, and it has been found in practice that in a few instances alkalies can be so used. It has, however, been found that in the greater number of instances it is not necessary to use either acid or alkali. Of the 80 licensees of the plaintiff whose reagents appear, it happens that 14 use alkalies, just twice as many as use acid, and, of these 14, 6 use lime, as does the defendant in two instances with X-cake, as does the defendant. Again, although the absence of both acid and alkali brings about a neutral pulp, six of plaintiff's licensees use a neutral agent. These substances, whether acid, alkaline, or neutral, are well characterized by

Mr. Chapman as gangue-correctives (R., Vol. I, p. 558, Q153; pp. 559, 560, Qs156, 159-163).

Among the 80 licensees 53 do not use any gangue-correctives at all, which is roughly two-thirds. Among the remaining one-third, just about one-quarter, or about 8% of the whole, use an acid gangue-corrective.

Thus there has been enormous use of the process of the patent in suit, most largely conjointly with the process of patent No. 835,120. For the flotation of porphyry ores the process of patent No. 853,120 is, in the majority of cases, greatly advantageous, but the process of the patent in suit No. 962,678 is in all cases absolutely necessary.

The revolution wrought in the practical art by the advent of the process of the patent in suit not only demonstrates the utility of that process, but evidences also its novelty and inventive character; and more specifically it evidences most conclusively that patent No. 835,120 did not disclose to the public the process of the patent in suit.

Errors of the Circuit Court of Appeals in Dealing with the Question of Anticipation of the Patent in Suit, No. 962,678, by Patent No. 835,120.

These errors which are numerous in detail arrange themselves chiefly into two classes, namely, first, that the agents in solution of patent No. 962,678 really preferentially coat the mineral particles like the oleic acid of patent No. 835,120 and, secondly, that the oleic acid of patent No. 835,120 really dissolves in part in the water of the pulp and that that forms the froth; and we will first consider the errors under those two headings and will later consider further errors that do not group themselves under either heading.

The Error of the Circuit Court of Appeals for the First Circuit in its Conclusion that the Mineral-Frothing Agents in Solution of the Patent in Suit No. 962,678 really preferentially coat the mineral particles as the oleic acid and other equivalent oily substances of Patent No. 835,120 do.

The Circuit Court of Appeals in the instant case apparently held that a soluble agent would coat the metalliferous particles

and on agitation produce a froth or scum for they say (R., Vol. I, p. 650):

> "The plaintiffs undertook to refute the disclosure of the New Zealand and the United States patents [Nos. 835,120, 777,273 and 777,274],—that a soluble agent would coat the metalliferous particles and on agitation produce a froth or scum,—by an experiment which they made; but the experiment amounted to nothing in the absence of the deduction drawn therefrom by the plaintiffs' expert witness, which deduction was contradicted and substantially refuted by the testimony of the defendant's witness."

Now the experiment or experiments here referred to speak for themselves. They were parallel experiments made first with the process of patent No. 835,120 using oleic acid as the agent and then with the process of patent No. 962,678 using phenol as the agent, and in each case the resulting froth concentrate was tested for the presence of a coating on the mineral particles.

The mineral particles resulting from the process of patent No. 835,120 were found to have froth-forming coatings upon them whereas mineral particles resulting from the process of patent No. 962,678 were found to entirely lack any coating.

These experiments we will now describe in detail.

The mineral particles in the froth resulting from the process of patent No. 835,120 still have a froth-forming coating upon them after separation from the water of the pulp and this coating is sufficient and effective to repeat the froth-formation process with fresh water without the addition of any more oleic acid.

The fact that the process of this patent No. 835,120 produces a froth of oil-coated mineral particles and that the oil-coated particles of the froth, after thorough washing with warm water, could be sunk and reagitated and would without any further addition of oleic acid reproduce the froth, was shown to the trial Court by the demonstration made by Mr. Higgins at Boston in what was described as the first experiment (R., Vol. I,

pp. 395-397), except that the latter part of the experiment was not carried on because defendant's counsel conceded that it would happen and would be "the same thing over again" (p. 397). And Mr. Higgins further testified that he had performed this complete experiment several times (pp. 447, 448, Q198), that the second froth was of the same nature and contained practically the same amount of mineral as the first (Q199) and that the frothing agent for the second agitation for producing the second froth came from the oily coating on the surfaces of the metalliferous particles (Q200), and that the oil was "practically completely removed from the pulp liquor" by the froth (p. 451, Q215).

Professor Taggart suggested by way of criticism of the experiment that the oleic acid was not attached to the metalliferous mineral particles but was present in detached particles of oleic acid upon the filter paper (R., Vol. I, p. 583, Q449), although he afterwards admitted that the solid matter, to wit, the metalliferous particles on the filter paper, was coated with oleic acid (R., Vol. I, p. 586, XQ451). He testified that if that concentrate had been shaken up with water and then allowed to stand, globules of oleic acid would have been visible (XQ458). He said he had done this, although not with the particular material which Mr. Higgins used (XQ459) and admitted that if the material were shaken you would get a mineral-bearing froth, but not very much (XQ462) (thereby contradicting the admission of defendant's counsel which the Court said must stand as made) and that the globules of oleic acid could be seen in the pulp between the settled solids at the bottom and a little layer of froth on top (XQ463).

Thereupon Mr. Higgins was recalled and contradicted these statements as to the presence of free oleic acid under the conditions stated (R., Vol. I, pp. 591, 592, Qs796-800). He further testified as to very careful experiments on his part wherein he had sunk the froth under such circumstances as to leave a clear surface of water to which free oleic acid would, of course, float, and then tested by a most delicate experiment which is generally accepted to indicate the presence of a trace of oil one molecule thick, which clearly indicated there was no possible free oleic

acid present; and he further states that if there was any free oleic acid in the froth it could be seen as globules by examination with a microscope, and that he had done this several times and had never seen any globules of oleic acid (R., Vol. I, p. 593, XQ805).

It may be noted that the Circuit Court of Appeals declined to witness an offered repetition of this test.

The mineral particles in the froth resulting from the process of patent No. 962,678 have no coating upon them after separation from the water of the pulp and upon re-agitation with fresh pulp water and without the addition of further frothing agent no mineral froth is formed and everything sinks to the bottom.

This was called the second experiment. In it the actual operations of the process of the patent in suit were shown to the trial Court in the Boston Demonstrations (the repetition of which was offered to the Judges of the Circuit Court of Appeals and declined by them) and not only by repeating defendant's infringing operations on a small mill scale, but also by an operation in a Gabbett mixer with a rotating agitator, following a specific example of the patent. The agent used was one of the organic substances named in the patent, phenol (R., Vol. I, pp. 398-401). The complete experiment involved also the removal of the froth, breaking it down and thoroughly washing it with warm water, and then returning the filtered and washed concentrate to the Gabbett mixer with the proper amount of acidulated water and re-agitating it, when, as stated by Mr. Higgins (R., Vol. I, p. 398):

> "it will be found that the froth will not be re-formed, that practically the whole of the concentrates will be left in the bottom of the Gabbett."

In other words the concentrate, after the mineral-frothing agent in solution had been separated from it by washing, was incapable of again forming a froth with fresh agitated pulp water. There was now no mineral-frothing agent present, either

in solution in the water or as a coating on the metalliferous mineral particles.

Since defendant's counsel stated his willingness to agree that everything would happen as Mr. Higgins had said it would happen (p. 399), only the first part of the experiment, to wit, the first agitation and froth formation, was then actually carried out. This experiment followed the other experiment, called the first experiment described above, which was an exact carrying out of the example of patent No. 835,120. In the two experiments everything used was the same except the mineral-frothing agent, which in the first experiment was the undissolved mineral-frothing agent oleic acid and in the second experiment was the dissolved mineral-frothing agent phenol, each in the small quantity claimed in the respective patents.

The two machines in which the experiments were carried out were identical, and the manipulations of these machines were identical. The essential difference was in the mode of operation of the process—the way the physical forces acted in the pulp to form a mineral-froth and so separate out the mineral and concentrate the ore. A difference in the appearance of the resulting froths was plainly apparent and was described by Mr. Higgins (R., Vol. I, p. 401).

Mr. Higgins further testifies, in regard to this and the other comparative demonstrations, as to the identity of the two machines (R., Vol. I, p. 448, Q201), and as to the showing made by these two experiments, as follows (R., Vol. I, pp. 448, 449):

> "Q204. What do these experiments demonstrate to you or show you?
>
> A. They show me that in the first experiment the mineral-frothing agent coats the metalliferous particles and that in the second experiment the mineral-frothing agent does not coat the mineral particles."

These experiments demonstrated to the trial Judge who witnessed them, and they would demonstrate to any other fair-minded person who witnessed them, that the mineral-frothing agents in solution of patent in suit No. 962,678 do not coat the mineral particles.

Mr. Higgins also testified to a wide range of experience of the same general character, demonstrating the same fact as will appear under the next heading.

The mineral-frothing agents of the process of patent No. 962,678 stay wholly in solution.

Mr. Higgins also affirmatively demonstrated that the soluble mineral-frothing agents stay in solution. He was asked if he had made other tests of the same general character as his second experiment in Boston with soluble mineral-frothing agents where the concentrate was washed and subjected to a second agitation in fresh water without the addition of any more frothing agent (R., Vol. I, p. 448, Q202) and he replied that he had and that the results in these experiments of the second agitation were as follows (XQ203):

> "The concentrates, instead of floating to the surface in the form of a froth, are practically wholly sunk in the liquid, only a minute quantity of mineral coming to the surface."

He then testified as to the class of experiments of the same general character as the second as follows (R., Vol. I, p. 449):

> "Q205. And referring now to the class of experiments of the same general character as the second, with soluble mineral-frothing agents, you say that these soluble frothing agents do not coat the mineral particles. What happens to the soluble mineral-frothing agents?
> A. They stay in solution."

The wide range of these experiments is then described (XQs. 206-208), including experiments with defendant's mineral-frothing agent alpha-naphthylamine. and he testifies that with this soluble mineral-frothing agent he had used the defendant's ore and the Miami Copper Company ore (Q209).

Asked whether he had described all of these experiments he said he had not, and then proceeded to describe the series supplementary to the particular kind of demonstration made to

the Court, to wit: experiments affirmatively showing that the soluble mineral-frothing agent was actually present in solution in the water of the pulp which remained with the gangue after the removal of the mineral-bearing froth which had been formed by the action of this soluble mineral-frothing agent (R., Vol. I, p. 449, Q210). Here, after formation and separation of the froth, he separated the pulp water from the froth and from the tailings by filtration. Two tests were made to obtain a sufficient amount of such pulp water and then with this in the right amount as the pulp water the experiment of agitating the mixture with fresh ore was repeated without adding any more mineral-frothing agent. As to these experiments Mr. Higgins testifies (*ib.*):

> "In every case I find that the ore floats with as much readiness and giving practically the same recovery as in the first treatment."

Mr. Higgins also describes a similar experiment with defendant's ore and frothing agent, carried on in a subaeration machine (R., p. 450, Q213). Machines of this type are elsewhere described in the record, for example, the Hebbard subaeration machine tested at the Inspiration mill (Chapman, R., pp. 555, 556, Qs115-120) with air flowing in at the bottom, impellers at the bottom and the froth taken off the top of the same vessel. This type of machine was also referred to in the quoted testimony of Professor Taggart which he admitted he gave in the *Butte & Superior* case (R., Vol. I, p. 302, XQ376, quoting XQ135 from *Butte & Superior* case). Two laboratory machines of this type were also exhibited in operation at Boston in what is called Mr. Higgins' third experiment, modified only in that they had no launders at the top for removing concentrates (R., Vol. I, pp. 401, 402, Qs46-48). Generally in these machines air enters at a pipe through the bottom, the revolving agitator above that pipe breaks up the air into small bubbles in the presence of a mineral-frothing agent, baffles above the agitator prevent the formation of a vortex, and a layer of froth is formed on the top of the liquid in the same vessel during the agitation and is normally overflowed during the agitation.

In a machine of this type Mr. Higgins carried on experiments as follows (R., Vol. I, p. 450, Q213): He used defendant's ore, defendant's mineral-frothing agent and lime, and obtained a froth and removed it. He then filtered the concentrates and tailings to separate the solution. He repeated the test to assure a sufficient quantity of the separated used solution, and then, with the proper quantity of the separated used solution, repeated the operation without adding any alpha-naphthylamine and obtained a froth of concentrates and removed the froth as before. The froth of the first treatment and the froth obtained with the used solution in the second treatment were assayed and the assays were substantially the same. In this case also he took some of the solution before use and some of the solution after the second use and by chemical color tests demonstrated (R., Vol. I, p. 450, Q213)

> "that substantially the whole of the alpha-naphthylamine was in the solution that had been used twice."

He further says that the chemical color determinations that he used give a somewhat rough determination, but indicated that the amount of alpha-naphthylamine in solution had not materially decreased in quantity (Q214). He then testified as follows (R., Vol. I, p. 451):

> "Q215. Now, putting it on the basis of consumption of mineral-frothing agent, let us say, given a practical operation, and the concentrates overflowed, what happens in the case of an insoluble mineral-frothing agent?
>
> A. The insoluble mineral-frothing agent coats the metalliferous particles and is practically completely removed from the pulp liquor. Thereafter it is of no further use in the process, except when the concentrates are retreated for the purpose of raising the grade.
>
> Q216. Now, upon the same basis, what happens with the soluble mineral-frothing agents?
>
> A. The soluble mineral-frothing agent stays in the solution or circuit liquor, as we call it, and is collected and used over again, when it proves to be a useful mineral-frothing agent, without adding any further quantity.
>
> Q217. For a fresh lot of ore?
>
> A. Yes, sir.

By the Court:

Q218. Can that be done indefinitely?

A. No, sir. The action of the air on a substance, particularly such as alpha-naphthylamin, oxidizes or decomposes the material. That decomposition is especially active in the presence of sunlight. All of these pulp liquors go from the circuit or filtering apparatus down to a pond which is always exposed to the light. This undoubtedly brings about decomposition of the substance, as I say particularly of a substance such as alpha-naphthylamin, and results in substantial loss, so that even though the circuit liquor is returned to the mill, fresh quantities of alpha-naphthylamin have to be added."

It may be noted that the demonstration and other experiments that Mr. Higgins made showing that the filtered and washed froth concentrate obtained with a soluble mineral-frothing agent in solution will not, when put into fresh water and re-agitated, produce a mineral-bearing froth, are confirmed by experiments which defendant's expert Professor Taggart admitted on cross-examination that he had made and published (R., Vol. I, p. 309, XQ414). The publication expresses Professor Taggart's theories, but it also states the facts. The facts are that he obtained a mineral-bearing froth with a tar acid (which would be phenol, cresol or other homologues), that the concentrate froth was drained by filtration and then agitated with a fresh amount of water, and that "no froth at all was produced." This confirmed the conclusion that the mineral-frothing agent stayed in solution and did not coat the mineral particles, but since such a conclusion was destructive of Professor Taggart's theories, he evolved another theory to explain this observed and admitted fact. This theory of Professor Taggart is that the soluble mineral-frothing agent was so firmly attached to the metalliferous mineral particles that it would not come off in the second operation, or act in any way in the second operation, so that the second operation was carried on as though no mineral-frothing agent whatever were present. In his publication Taggart proceeded to say that an amount of the tar acid equal to the amount which he assumed was attached to the mineral par-

ticles, produced an appreciable froth when in solution in water with no solid material present. Just exactly how he determined what was the amount of what he calls "adsorbed oil" which, according to his theory, was so firmly attached to the mineral that it would not function in the process, he does not anywhere say.

In re-direct he attempts an explanation (R., Vol. I, p. 312, RDQ425) and puts forward his theory and says:

> "the second part of the experiment was just to show that if we could have gotten the material that was adsorbed onto the sulphides off, there was enough of it there to froth."

Apparently therefore he could not get it off and did not get it off and since his theory assumed that it went on, he assumed because it did not come off that it was still on, a species of logic by which an original unbased assumption is sought to be strengthened by a second unbased assumption. It is a mere speculative theory that is wholly immaterial to any issue here. But it greatly misled the Circuit Court of Appeals for the First Circuit.

Professor Taggart also testifies rather indefinitely about using over again the solutions from which mineral-bearing froths produced by mineral-frothing agents in solution have been separated, but *admits the fact that you can use them over again and get a froth,* and says that there is a certain amount of soluble mineral-frothing agent taken off every time (R., Vol. I, pp. 307, 308, Qs397-403). It is, of course, a well-known fact that always in the handling of liquids there is a slight loss. When the liquid is poured out it adheres more or less to the surfaces of the walls and bottom of the vessel. There is not the slightest indication that he carried on these experiments in the careful manner that Mr. Higgins did so as to obviate any effect from these losses by doing the experiment twice and then taking from the total amount of solution the required amount for the second agitation and froth formation.

There is other evidence on this subject adduced by the defendant in a statement appearing in the alpha-naphthylamine patent

under which defendant attempts to justify its infringement, to wit, the Corliss patent No. 1,228,183 of May 29, 1916. This patent is Defendant's Exhibit 126 (R., Vol. II, p. 1222) and the statement is as follows (lines 65-71):

> "the circuit water recovered from the concentrate and even that recovered from the tailings contains notable amounts of alpha-naphthylamin which can thus be returned to the process with resulting economy in the amount required to be added for subsequent operations."

This statement may be contrasted with the testimony of defendant's other expert, Dr. Bacon, on the subject. Dr. Bacon's mental processes are troubled by the same speculative theory that is put forward by Professor Taggart. He starts off by saying, relative to the cost of alpha-naphthylamine (R., Vol. I, pp. 344, 345, Q21), that "we" (and "we" may be presumed to mean Mr. Corliss and possibly others and himself) "were rather worried about the thing from the commercial standpoint," i.e., the cost of the alpha-naphthylamine, and further

> "and it seemed to us that you ought to be able to return that circuit water and add extremely little more, or virtually no more, X-cake and make another float, and so on, and thus use very little. But we found that that was not the case."

This statement of Dr. Bacon exactly contradicts the above quoted statements of Corliss in the published patent.

Dr. Bacon proceeds and says that "we" reached the conclusion that the X-cake "was adsorbed against the ore particles and principally against the mineral particles." He was asked whether he made any quantitative determinations (R., Vol. I, p. 345, Q25). He answered:

> "We tried to. We got some figures. *I do not know how accurate those figures are,* because you will understand that in any of this work, where you are trying to measure the amount of adsorption on surfaces, you are dealing with extremely minute quantities of substances, and the methods for measuring such extremely minute

> quantities of substances have not been developed to the extent that we would like."

He then further says that there was about ten times as much of the X-cake adsorbed on the sulphide surface as on the gangue surface. He further says (R., Vol. I, p. 346, Q28):

> "We made experiments like this:—We took some of this material on which the X-cake had adsorbed and we washed it thoroughly with water, so it was not a question of simply adhering solution, and then we dissolved the X-cake off with alcohol, and then we made chemical test to determine that it was X-cake."

He did not give the figures until cross-examination, and then it appeared that on the sulphide or metalliferous mineral he or his experimenters had found 0.00025 grams, and on the gangue 0.000025 grams. These figures in the first instance represent twenty-five one hundred-thousandths of a gram, and in the second instance twenty-five one-millionths of a gram. Having in mind that a gram is approximately one four-hundred-and-fiftieth of a pound (R., Vol. I, p. 365, XQ118) the minuteness of the character of this determination may be to some extent appreciated. Roughly the first figure is a half of a millionth of a pound and the second figure is a twentieth of a millionth of a pound.

These determinations, in which the witness himself expressed no confidence, are immaterial and of no probative value.

The demonstrations and oral evidence above fully reviewed, establish conclusively that when a mineral-frothing agent in solution is used in a froth-flotation process of ore concentration, the mineral-frothing agent stays in solution and does not coat the metalliferous mineral particles, in contra-distinction to what occurs when a mineral-frothing agent is used which remains undissolved and coats the mineral particles, as in the process of patent No. 835,120.

The trial Judge who heard the evidence and saw the demonstrations accepted this fact as proved. He says, comparing the process of patent No. 835,120, which he refers to as the first patent, with the process of the patent in suit (R., Vol. I, p. 620):

> "But the principle of action,—so far as it is known,—involved in the process in suit, is not the preferential affinity of the frothing agent used for the mineral particles or the coating of those particles, or the attachment of air bubbles to coated particles, as in the first patent, because the frothing agent goes into solution without coating either mineral or gangue, and the law of attraction and attachment of air bubbles to oil-coated mineral particles cannot apply. The process in suit, as it is put by counsel for plaintiff in their brief, 'proceeds by reason of the peculiar character of the air bubbles produced in water, modified by the presence of the dissolved mineral-frothing agent employed, and by reason of the attraction and attachment of such air bubbles for uncoated metalliferous mineral particles'."

The Circuit Court of Appeals for the First Circuit in support of their erroneous conclusion cited a certain "adsorption theory" advanced by defendant's expert witnesses and said (R., Vol. I, p. 650):

> "Then again, the disclosure of these two prior art patents [patent No. 835,120 and the New Zealand patent No. 19,633],—that agents having a preferential affinity for metalliferous matter coat the mineral particles with a slight film,—is supported by the adsorption theory presented in evidence through defendant's witness Taggart, that such agents, though in solution, will attach themselves to and slightly coat the mineral particles."

The theory of defendant's witness Taggart that mineral-frothing agents in solution come out of solution at the surfaces of the mineral particles and attach themselves to and slightly coat the mineral particles, although completely discredited by the evidence, was accepted by the Circuit Court of Appeals. We shall now consider that theory.

The adsorption theory.

Judge Peters, in his opinion commented upon the evidence as to the phenomena of adsorption in comparing the process of the patent in suit with the process of patent No. 835,120, just prior

to expressing the conclusion that mineral-frothing agents in solution stayed in solution in the operation of the process and did not coat the metalliferous mineral particles. He said (R., Vol. I, p. 619):

> "Into this field, with the process of the first patent as a part of the prior art, came the patentees of the second patent,—the patent in suit,—with an undoubted improvement; a process not dependent upon the oily coating of the mineral particles but utilizing a hitherto unknown property of mineral-frothing agents in solution to form air bubbles which attract and attach themselves to the uncoated and unoiled mineral particles. It should be said, however, that the defendant attacks the accuracy of the above general statement and maintains that it is not true that in the process of the second patent the mineral-frothing agent in solution forms bubbles which attach themselves to uncoated mineral particles. It says that, while the frothing agent goes wholly into solution in the water of the 'pulp,' a small part of it comes out again by 'adsorption' and does coat, minutely, the mineral particles,—so that it is the same process with a different agent. This is a region of disputation where experts and scientists occupy the field alone. They have battled valiantly, but with the result that I cannot say that I am convinced that the 'adsorption' theory has any practical applicability here."

Adsorption is an extremely minute amount of either increase in the concentration or decrease in the concentration of a solution which takes place at the surfaces where the solution comes in contact with another substance, such as the walls or bottom of a vessel or the air at the top surface, or a bubble in the solution, or a solid particle in the solution, either mineral or gangue. It is in this ore concentration art an altogether useless and negligible thing, although in the dyers' art it is a useful thing.

In the froth-flotation art it is an uncontradicted fact that there is no relation of cause and effect between adsorption and mineral-froth flotation. Although a number of soluble mineral-frothing agents cause positive adsorption (i. e., minute increase of concentration in any surface layer of the solution), this quality of causing positive adsorption

is equally true of such a substance as saponine (Higgins, R., Vol. I, p. 470, Q338) which is not a mineral-frothing agent and is named in the patent in suit as a soluble substance which is not a mineral-frothing agent (R., Vol. II, p. 664, spec. p. 1, line 49); and more conclusive still, common salt, sodium chloride, which with copper ores acts as a mineral-frothing agent in solution, causes negative adsorption (i. e., minute decrease in the concentration of the dissolved substance in the surface layers of the solution) (Higgins, R., Vol. I, p. 472, Q348; summing up pp. 470-472, Qs337, 347).

Adsorption takes place wholly in the solution. Its magnitude is microscopic, within the range only of molecular attraction, i.e., it is present in a surface layer of the solution only one molecule thick. If and when positive adsorption takes place in the part of a solution which is in contact with an absorptive substance, such as a fabric to be dyed, the concentrated solution is absorbed by the fabric and a direct benefit results. When positive or negative adsorption takes place in the part of a solution which is in contact with a non-absorptive substance, such as a particle of metalliferous mineral or a particle of gangue, nothing further happens. There is conclusive evidence of this in the undisputed facts above stated that of two substances one of which in solution causes positive adsorption (concentration) and the other of which in solution causes negative adsorption (dilution), both act as mineral-frothing agents in solution. There is further conclusive evidence of this in the undisputed fact that of the substances which in solution produce positive adsorption some do and at least one does not act as a mineral-frothing agent in solution. Therefore the minute and microscopic phenomena of adsorption are wholly negligible in mineral-froth flotation and the theories built thereon, being contradicted by the facts, must be discarded. Nevertheless the Circuit Court of Appeals in the instant case, accepts and approves the "adsorption theory presented in evidence through defendant's witness Taggart" (R., Vol. I, p. 650).

Of the testimony of defendant's witnesses setting forth this theory, we will first discuss that of Dr. Bacon, which covers the whole subject.

Dr. Bacon first gives an erroneous definition of adsorption as (R., Vol. I, p. 345, Q24) "the coming out of solution onto a solid surface and even onto a gas surface." He further says:

> "Wherever there is a surface, the concentration of the substance is always greater near that surface, and it may come out of solution at that surface, and when I say 'adsorption' in this connection, I mean the actual coming out of solution onto the surface to change the surface to a minute extent."

This erroneous definition he modifies in cross-examination to the extent of saying that the word "adsorption" includes both the concentration within the liquid at the surface of the liquid and the coming out of solution on to the opposed surface (R., Vol. I, p. 359, XQ86), and further admits (p. 360, XQ89) that a number of scientists use the word adsorption referring only to the concentration in the surface layer of the liquid, and therefore in the liquid (XQ90). Again he compares the adsorption which takes place in the dye industry (*i.e.*, the actual transfer of the dye material that was in solution in the dye liquor into the material of the fabric to be dyed by reason of the *absorptive* nature of the fabric), with the adsorption which he says takes place in froth-flotation concentration (p. 361, XQs91, 92), although he admits that the defendant's agent alpha-naphthylamine does not go into the copper, whereas the dye goes into the fabric (XQ93). He also admits that adsorption is a phenomenon in the range of molecular attraction (XQ95). His theory is therefore that when a solution comes in contact with another substance, whether it is a solid or air, whether it is mineral or gangue, there is not only a minute increase of concentration in the liquid at the contact surface but also a minute shooting of molecules either into the air or against the solid surface, and that this in froth flotation with mineral-frothing agents in solution, causes the solid particles (all of them) to be minutely coated with the mineral-frothing agent which, according to his theory, is precipitated out of the solution and on to the surfaces of the solid particles.

He was then asked about negative adsorption, which he had completely ignored, and the example of common salt was given

to him (R., Vol I, pp. 361, 362, XQs96, 97). Here he confessed his ignorance, but admitted that there is such a thing as negative adsorption (XQs98, 99) and contrasts it with positive adsorption, as follows (XQ100):

> "In negative adsorption you would have the opposite situation that instead of there being a concentration, there would be a lesser amount.
> XQ101. A dilution?
> A. A dilution, yes."

Of course with the opposite situation the minute molecules of the substance in solution would shrink away from the air bubble particles and if, as the fact is, mineral-froth flotation can be attained with a substance in solution which exhibits negative adsorption, e. g., common salt, then the entire theory that the coating of solid particles by minute molecules precipitated out of solution is the cause of or contributes to the mineral-froth flotation phenomena, must be abandoned.

Professor Taggart's testimony as to adsorption is very general and indefinite. He treats it as a concentration phenomenon, altogether overlooking the negative or dilution phenomenon (R., Vol. I, pp. 254, 255, Q149) and gives the illustration of the dyeing industry (Q150) where unquestionably adsorption helps absorption. He utterly fails to explain how a substance in solution which effects negative adsorption of the solution can produce mineral-froth flotation, and therefore he, as well as Dr. Bacon, stand upon a theory which is contradicted by the facts and therefore must be discarded.

The real purpose of this erroneous theory of precipitation of minute molecules out of solution and on to the surfaces of solid particles suspended in the solution, is the endeavor to establish the fact that there is no difference between a fixation on the mineral particles of undissolved oily material having a preferential affinity for metalliferous matter, such as undoubtedly occurs and had been known for years to occur when oil and water and ore are mixed together, and the wholly different phenomena that occur when there is a substance dissolved in the ore pulp; and the real object in seeking to establish this

theory is to argue therefrom that the mode of operation is substantially identical in froth-flotation processes whether undissolved frothing agents or dissolved frothing agents are used. And this is made further evident by the effort which failed to establish the fact that this alleged precipitation of solid particles acts preferentially on the mineral particles. Dr. Bacon's experiments above considered were adduced to prove this alleged preferential precipitation and fixation, and the figures so apologetically put forward by him of ten times as much X-cake on the mineral as on the gangue are supposed to show this preferential action. But Dr. Bacon's experiments utterly failed to show the preferential action which he hypothesized. He testifies that he washed the solid materials with water 37 times (R., Vol. I, p. 369, RDQ136), although he did not testify that he dried the materials before washing them. He describes these washings (R., Vol. I, pp. 363, 364, XQ109) and in his description says (p. 364:

> "That on passing successive portions of water through, *the X-cake comes off very much faster from the gangue material—the granite—than it does off the chalcopyrite* [the metalliferous mineral]. That is, you find in the early stages of the testing that the filtrate, that is, the water which has passed through the gangue material, contains more of the X-cake than the one which has passed through the chalcopyrite."

Obviously if the X-cake came off the gangue "very much faster" than from the metalliferous mineral in these 37 successive washings, the condition of the gangue and mineral as to the minute amounts of X-cake remaining with them at the conclusion of these washings showed absolutely nothing as to what that condition was when the froth was formed and separated. If at the beginning of the operation the same or a greater amount of X-cake had been adsorbed on the gangue than on the metalliferous mineral, as he denies, the results might well be expected to be such as he says he found them. In other words, these experiments do not show that this minute adsorption phenomenon acts preferentially, and are quite consistent with

the hypothesis that it acts in froth formation not preferentially and selectively but indifferently and equally in relation to both gangue and mineral, and is a phenomenon which is minute and practically infinitesimal and is altogether negligible in the process of froth-flotation ore concentration.

Error of the Circuit Court of Appeals for the First Circuit in its conclusion that oleic acid and the other oils and oily substances of patent No. 835,120 are really partly soluble in the water of the pulp and that the mineral-froth phenomenon of that patent is due to that partial solubility.

The Circuit Court of Appeals for the First Circuit in support of its conclusion of anticipation of the patent in suit by Patent No. 835,120 wandered into the field of speculation on its own account, although inexperienced and untrained in the art. It said (R., Vol. I, p. 651):

> "Furthermore, a study of the testimony in the case *and the reason of the thing* have convinced us that oleic acid (the agent specifically named in patent No. 835,120 and declared to be immiscible in the patent in suit) and all the mineral frothing agents that have been used in these processes, in the limited amount prescribed of a fraction of one per cent on the ore, are soluble to some extent because *you cannot get froth flotation unless there is present a constituent soluble to an extent sufficient to produce the requisite froth or scum,* and the fact that oleic acid, when so used, produces the requisite froth or scum."

This was the theory of defendant's experts and, as we shall point out, it was whittled down to an admission that oleic acid was as soluble as window glass. With an infinity of time and oceans of water it would probably be possible to dissolve out of our windows the window glass which protects us from the weather, but we are not dealing with operations that take place over geologic ages but with the daily operations of great mills where thousands of tons of material are rapidly flowing through under treatment. Therefore, any solubility such as would result

from flowing water over window glass may be wholly disregarded, and this, according to the evidence, is the degree of solubility of oleic acid. For all practical purposes, and especially as used in the process of patent No. 835,120, oleic acid is insoluble. As Professor Taggart said early in his testimony (R., Vol. I, p. 211, Q. 38):

> "glass certainly would not be considered soluble for the purposes of flotation."

Although the process of patent No. 835,120 is explicitly founded upon and is carefully limited to the use of oily substances that act by reason of insolubility in water, defendant contends and endeavors to prove that a small amount of the oleic acid disclosed in that patent dissolves in the amount of water normally used and under the conditions of agitation disclosed in that patent, the intent being to prove that those who used oleic acid used a substance a trace of which dissolved, although they did not know it. Professor Taggart testifies as to tests wherein he determined, he says, that with 1 part of oleic acid to 4000 parts of water, in one case 5.6% and in another case 8% of that 1 part of oleic acid dissolved. In his direct examination a chart alleged to show solubilities determined in these and other tests was put in evidence as Defendant's Exhibit 95 (R., Vol. II, p. 1099) and generally described (R., Vol. I, pp. 237-239, Qs103-108a). This followed an earlier statement in answer to the Court's question (R., Vol. I, p. 217) from which we quote as follows:

> "If you go down to 1 or 2 pounds per ton of ore, which is the usual proportion there, I have made actual quantitative determinations of the amount in which oleic acid dissolves, and found that it was quite a sensible amount. I have forgotten just the particular figures, but as I recollect, somewhere between 6 and 10 per cent., dissolved in those proportions."

In cross-examination this statement was repeated to him and he was asked the exact figures and he gave them as crude oleic acid 5.6% and pure oleic acid 8% (R., Vol. I, p. 288, XQ292)

of the two pounds of oleic acid per ton. The details of these tests were then elicited (pp. 288, 289, XQs293-300). He says that in each test an oily residue was obtained from the water and represented the material that went into solution in the water in the test, but he failed to identify this residue as oleic acid. His testimony on this point is significant (R., Vol. I, pp. 290, 291, XQ304):

> "XQ304. Now, how did you identify that residue as oleic acid?
>
> A. Purely by elimination. There could not possibly be anything else there but that which had come out of the oil that was put in, and the oil that was put in was material that is bought under that name in the market. Of course, we assumed by elimination, that was oleic acid. There was no chemical test made for the actual determination of this material, because whether it is oleic acid, chemically pure or not, was not of any particular importance in this particular connection."

Obviously this residue, amounting in his experiments to from about two to three one-hundredths of a gram (0.0196 to 0.028 grams), may have been merely impurities such as are present in most substances and should be eliminated and totally disregarded in determining the qualities of the substances.

Finally he was asked whether what he called the solution of the oleic acid was absolutely clear with no opalescence, and he answered (R., Vol. I, p. 292, XQ312):

> "there was the slightest suggestions of opalescence. It was apparently utterly impossible to filter out to perfectly clear mixture."

And again he repeats the statement (XQ313):

> "If you get it out there in the full sunlight and hold it against something dark, you would get a suggestion of opalescence."

These determinations therefore did not come up to his own standard. In answer to cross-questions he had testified (R., Vol. I, p. 230, Q81):

"By the Court:

Q81. How do you tell about the solubility where your element is not clear in the water?

A. Ordinarily if there is not solution, the water will be clouded. The light in passing through is bent more or less as it passes from the water into the other substance and then bent as it comes out, and you get a cloudy effect instead of a clear effect."

Prior to that he had testified (R., Vol. I, p. 212, Q40)

"the proper thing to do is to take the every-day commonsense understanding of the word 'solution,' namely, the production of a mixture that looks just like water, or at least is clear."

Mr. Higgins gives practically the same standard in different language, using the word "brilliant" instead of "clear," and says that the solution must be "perfectly transparent" (R., Vol. I, pp. 486, 487, XQ432).

No argument can explain away the fact that in these tests in which Professor Taggart was dealing with minute amounts he did not get a clear or brilliant solution, and therefore he got a body of water which contained undissolved oleic acid.

And since, as above noted, he did not even determine whether the residue which he extracted from what he called his solution was oleic acid or was composed of impurities, he utterly failed to determine that any minute or measurable proportion of oleic acid was soluble under froth-flotation conditions.

As to the other tests shown in the chart Professor Taggart admits that in none of them did he determine the character of the residue obtained from what he called his solutions (R., Vol. I, p. 294, XQ329) and that the so-called solutions were not determined to be clear and free from opalescence in strong sunlight (XQs330, 331). This being so, the chart and its determinations may be dismissed from further consideration, except that it is well to note that his determination that 4% of the impure X-cake used by defendant in its mill would not dissolve cannot, of course, be accepted as modifying the admission that alpha-naphthylamine is soluble to an extent far in excess of the proportion actually used by the defendant (*infra*, p. 129), and

also that his determination in the ratio of 1 part of alpha-naphthylamine to 4000 parts of water was very far from the actual conditions in defendant's mill wherein less than half a pound of alpha-naphthylamine was dissolved in 10,000 pounds of water so that the actual ratio was not greater than 1 to 20,000.

The subject of tests of solubility is further illuminated by the testimony of Dr. Bacon. He testified generally that all successful flotation agents, and by this he meant mineral-frothing agents, "were partly or wholly soluble in water, in the proportions used" (R., Vol. I, p. 342, Q12). This, of course, included oleic acid. In cross-examination his attention was called to that statement, and he said that it was based upon "a large number of experiments which we had made which demonstrated that fact" (R., Vol. I, p. 353, XQ62).

He was then asked if he had demonstrated that fact in relation to oleic acid (XQ63) and at great length and evidently from not too accurate memory, he describes a number of experiments (R., Vol. I, pp. 353-355, XQs64-66). He was then asked for quantitative determinations (p. 355, XQ67) and in his long answers failed to give any quantitative determinations. This was called to his attention by the Court and Dr. Bacon admitted that he had not made any quantitative determinations (R., Vol. I, p. 357, XQ69), and it may be noted here that later, in his recross-examination, he reiterated that he expressed no opinion as to the quantity of oleic acid that was dissolved in his experiments (p. 371, RXQ144). In his cross-examination the Court asked him if glass dissolved to some extent (p. 357, XQ71) and he answered that it did, and then followed an answer to a further question by the Court from which we quote as follows:

> "By the Court:
> XQ72. You would not call glass soluble in water?
> A. I think you would in the sense that we are talking of here, for the reason that the quantities of substances that we are talking about that are used in flotation are so extremely small."

Thus we find that Professor Bacon in the sense in which he has been testifying, to wit, as to the order of magnitude in

which oleic acid is soluble, regards glass as soluble in water. This contradicts Professor Taggart's testimony. Professor Taggart had selected the minute and almost infinitesimal solubility of glass as an extreme example and had disclaimed that standard in his testimony as to the solubility of mineral-frothing agents, testifying as follows (R., Vol. I, p. 211, Q38):

> "For instance, the chemists in making their refined measurements considered glass soluble. Now, we do not ordinarily think of glass as soluble, and *glass certainly would not be considered soluble for the purposes of flotation.*"

Again, he protested against being led to the point of such solubility as was comparable with the solubility of glass as follows (R., Vol. I, p. 218, Q55):

> "The reason that I hesitated there was that I thought that your question had said that all of them were completely soluble in some proportions. That is, that if you have used a small enough amount of it with respect to the water, that in every case it would all go into solution. That is not the case *unless the definition of solubility is strained considerably, that is, to the point where, for instance, we say that glass is soluble.* If we went to that point, then that latter statement might be true, but *that I do not think, is a proper length to go.*"

Again, returning to Dr. Bacon, we find that the Court continued to interrogate him as follows (R., Vol. I, p. 358, XQ73):

> "XQ73. Well, then, under your interpretation of the word 'soluble,' glass is soluble.
> A. Yes, sir.
> XQ74. Would anything be not soluble?
> A. The trouble is that measurements have not been made. Now, I really think that if you go far enough, everything does have a slight solubility in water."

Dr. Bacon fittingly closed this subject in redirect examination as follows (R., Vol. I, p. 370, RDQs141, 142, 143):

> "RDQ141. What I am trying to get at, Dr. Bacon, is whether the oleic acid added to the water there was

in the proportions of flotation as they have been discussed here?

A. You mean the oleic acid added originally to the water?

RDQ142. Yes.

A. Yes.

RDQ143. Do you know whether glass, *if added to water in that proportion,* would show any discoverable solution of glass in the water?

A. *Absolutely.* When I say 'glass,' you will understand there is a great difference in the solubility of different glasses. There are some glasses which are quite soluble. In fact, *the ordinary glass that is used for window panes is fairly soluble.* Then, they make other types of glass, like the glass that is used for chemical glassware, that is quite insoluble, but *the ordinary type of soda lime glass that is used for some purposes is fairly soluble in water and is of the same order of magnitude as the oleic acid that we are talking about."*

That is certainly straining the definition of solubility beyond what "is a proper length to go." Nevertheless the Circuit Court of Appeals for the First Circuit, accepting Taggart's *ipse dixit* that you cannot get froth flotation unless there is a soluble constituent present, profess to find in January, 1929, a new explanation of the mineral-froth phenomenon of the oleic acid process of patent No. 835,120, which phenomenon is attributed in the patent to the preferential coating of the mineral particles by the oleic acid—an explanation of the phenomenon which this Court and the English House of Lords have also accepted. The Circuit Court of Appeals for the First Circuit now discovers that the froth-flotation phenomenon of the oleic acid process was due to the dissolving of a part of the oleic acid in the water of the pulp.

Error of the Circuit Court of Appeals for the First Circuit in its understanding and use of the phrase "Preferential affinity for metalliferous matter over gangue."

This descriptive language, used in patent No. 835,120, and quoted and repeatedly used in the decisions of this Court in

Minerals Separation v. *Hyde* and *Minerals Separation* v. *Butte & Superior Mining Company*, as above referred to, unquestionably means that quality of a substance which causes it, when in undissolved condition in the water of an ore pulp, to coat the metalliferous mineral particles suspended in the pulp in preference to the gangue particles suspended in the pulp as in consequence of the agitation it comes in contact alike with the mineral and gangue particles in the pulp. To exercise this preferential affinity the substance must remain undissolved. It is the old and well-known characteristic of oily substances brought in undissolved condition in contact with metalliferous mineral and rock or gangue immersed in water. The oil has a strong affinity for the metalliferous material and the water has a strong affinity for the rock or gangue, so that the oil, which is repelled by the water, coats the metalliferous material in preference to the gangue, and the water wets the gangue in preference to wetting the metalliferous mineral.

What was said by this Court has been fully considered above.

The British litigations involving flotation processes dealt with the Elmore patents wherein this preferential affinity was described as "the selective action of oil" (*British Ore Concentration Syndicate, Limited* v. *Minerals Separation, Limited*, 27 R. P. C. 33), but Lord Atkinson, in interpreting the disclosures of Elmore patent No. 6519 of 1901 spoke of "a mixture of powdered ore, oil and water" wherein the oil had "in accordance with some obscure chemical law or *affinity*, seized upon the metallic portions of the ore in *preference* to the earthy particles" (*British Ore Concentration Syndicate, Ltd.* v. *Minerals Separation, Ltd.*, 27 R. P. C. at 49), thereby in effect defining preferential affinity.

The term "the selective action of oil" appears in the Cattermole British patent 26,295 of 1902 (R., Vol. II, p. 902, lines 5, 6; p. 903, lines 31, 32) which in the process produces "oil-coated metallic mineral particles" (p. 902, line 22). It also appears in Cattermole U. S. patent 763,260 associated with a statement of the preference, as follows (R. Vol. II, p. 970, lines 20-28) ::

> "when a mixture of powdered metalliferous matter and gangue is treated with oil suspended in water * * * the oil has a more or less selective action and will coat

> the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water."

This language is exactly repeated in Cattermole patent 777,273 (R., Vol. II, p. 974, lines 17-24). Cattermole, Sulman and Picard patent 777,274 speaks of "the superior physical attraction exerted by minerals for fatty or resin acids" (R. Vol. II, p. 982, lines 13-15), with the result in the process that "the mineral particles become attached to or more or less coated by films of fatty or resin acid" (p. 982, lines 54-56). Thus in this art the quality of "preferential affinity" or "superior physical attraction" of oils undissolved in water for metalliferous mineral particles as contrasted with their lack of affinity for gangue particles, resulting in "selective action of the oil" in coating the mineral particles in preference to the gangue particles, was old and well known. The term "preferential affinity" as used in patent 835,120 has a clear, precise and definite meaning and depends upon the presence of an undissolved oil in the water of an ore pulp. It had that meaning in bulk-oil or oil-buoyancy flotation processes, and it had that meaning in metal-sinking processes. Its use in patent 835,120, as recognized by this Court in its prior decisions, necessarily implied oil undissolved in water. The whole art prior to the patent in suit wherein oil was used, utilized only oil which remained undissolved in the water of the ore pulp, and utilized it to coat the metalliferous mineral particles in preference to the gangue particles. With what might happen from the dissolving of any soluble constituents of the oil, if they happened to be present, the prior art was not concerned and had no knowledge whatsoever.

In their opinion in discussing patent No. 835,120 the Circuit Court of Appeals for the First Circuit first quote the paragraph of its specification containing the limitation to "substances which have a preferential affinity for metalliferous matter over gangue" (R., Vol. I, p. 645).

In the next paragraph that statement is repeated in a proper statement of the discovery on which the process of that patent is based.

In the next paragraph occurs the following statement:

> "The specification of that patent does not differentiate between the oils, fatty acids or other substances having a preferential affinity for metalliferous matter in the sense that they are soluble or insoluble, or in part soluble and in part insoluble, and the terms miscible and immiscible, soluble or insoluble, are nowhere mentioned in the specification or claims of the patent. The specification and claims, however, speak of the mineral particles being 'oil-coated' or as having been brought into 'efficient contact with' the oil or agent used."

It will be noted that this statement overlooks the fact that preferential affinity for metalliferous matter in an ore pulp can only be exerted by a substance which remains undissolved in that ore pulp. The "oil-coated" condition of the metalliferous mineral particles and the "efficient contact" of the metalliferous mineral particles and oil or agent used can only result from the presence in the ore pulp of an undissolved oil or agent. The opinion then says (R., Vol. I, pp. 645, 646):

> "On account of this the plaintiffs contend that the frothing agents disclosed in that patent (No. 835,120) are immiscible; and that only immiscible agents will coat or be brought into efficient contact with the mineral particles. While some of them are undoubtedly substantially insoluble or immiscible, others are substantially soluble, or partly immiscible and partly soluble; and the disclosure of the patent by the use of the terms 'oils, fatty acids, or other substances having a preferential affinity for metalliferous matter over gangue,' does not differentiate between them as frothing agents or point out any which, if used in the limited amount of the patent [a fraction of one per cent on the ore] will not coat the mineral particles. On the contrary the specification and claims clearly give one undertaking to practice the process of the patent to understand that any or all of them will coat the mineral particles."

This statement is highly confused. While it is true that this Court held that the term "oils, fatty acids, or other substances

having a preferential affinity for metalliferous matter over gangue" does not differentiate between them as to their quality or degree as frothing agents, it clearly held that it did require the presence in the ore pulp of undissolved substances and considered only the operation of such undissolved substances. The last sentence of the above quotation is accurate. The error of the Circuit Court of Appeals, persisting throughout its opinion, is the failure to comprehend that to exercise preferential affinity in an ore pulp the substance must remain undissolved in the ore pulp.

The conclusion of the consideration by the Circuit Court of Appeals of the prior decisions of this Court in the *Hyde* case and the *Butte* case is that this Court found as to the oily liquid or oily substance (R., Vol. I, p. 647):

> "that the only limitation was that it should have a preferential affinity for metalliferous matter."

This is not quite accurate since there was also the limitation expressed in those decisions, as a necessary consequence of that preferential affinity, that it should coat the metalliferous mineral matter in the ore pulp, but aside from that if this had been the only limitation, it would have been sufficient to exclude from the operation of the process of patent No. 835,120 any substances that dissolved in the ore pulp. The term "preferential affinity" was wholly misunderstood by the Circuit Court of Appeals. They conceded that this Court had held it to be a limitation clearly imposed but they failed to understand that it of necessity required the presence of a substance that remained undissolved in the ore pulp and preferentially coated the metalliferous mineral particles.

Errors of the Circuit Court of Appeals for the First Circuit in the instant case in misquoting and misunderstanding the opinion of this Court in the Butte & Superior case.

The last paragraph on page 647, continuing on page 648 (Vol. II) of the opinion of the Circuit Court of Appeals contains confused and erroneous quotations from the opinion of

this Court in the *Butte & Superior* case, with unjustified bracketed insertions indicating a complete misconception of the meaning of the language of this Court. This Court was only considering there whether or not the petroleum products, kerosene oil and fuel oil, both insoluble substances, were oils of patent No. 835,120. This Court said (250 U. S. 348) "the question we are discussing relates only to the use of petroleum products." Their quality as frothing agents was under consideration. Plaintiffs had contended that they were not frothing agents. This Court held that they were frothing agents of the patent 835,120 —whether more efficient or less efficient was unimportant, since they were oils which unquestionably had a preferential affinity for metalliferous matter over gangue, and therefore were within the broad description of the specification. The Circuit Court of Appeals, failing to comprehend the actual question that was being considered by this Court, by misquotations and by unwarranted interpolations, put forward its interpretation as though this Court had been considering whether or not these petroleum products were insolube (immiscible) or soluble (miscible). That question was not under consideration. The agents being considered, kerosene oil and fuel oil, are wholly insoluble and immiscible substances. Nobody denied that. No question of solubility entered into the subject matter this Court was considering. Yet, the Circuit Court of Appeals appears to have considered that question as the only question under consideration, and in fact it treated the decision of this Court as determinative of that question, although that question was not in any way involved in what this Court said or decided.

We will now correctly quote from the opinion of this Court in the *Butte & Superior* case, the paragraph above referred to (250 U. S. at 349, 350):

> "It is argued that the provision of the claims that the mixture prescribed, of oil, water, and ore, shall be agitated until the oil-coated mineral matter forms into a froth, serves to differentiate the 'frothing oils' from others having the required preferential affinity for metalliferous matter, but which, when agitated in the mixtures, may not produce the characteristic froth, if any such there are, and that a proper construction of the

> patent limits it to such 'frothing oils,' and renders the use of them in a fraction of 1 per cent on the ore an infringement when used with 'non-frothing oils' having the required affinity in amounts sufficient to make the combination exceed the quantity limit of the patent."

In the opinion of the Circuit Court of Appeals for the First Circuit (Vol. I, p. 647, last paragraph, continued on p. 648) this paragraph was broken up into two quotations and from the second of these quotations essential words were omitted and to it unjustified interpolations were added. At page 647, line 7 from the bottom, the words "for metalliferous matter" after "affinity" were omitted. In line 5 from the bottom the words "if any such there are" following the word "froth," were omitted from the quoted part and inserted in an interpolation, but were preceded there by the word "immiscible," so that the bracketed part reads "[immiscible, if such there are]." The same unjustified interpolation was repeated on the bottom line of page 951 and top line of page 952, to wit "[immiscible, if such there are]."

The oils referred to in the above quotation as "having the required preferential affinity for metalliferous matter" but which, when agitated in the mixture, may not produce the characteristic froth, were the insoluble petroleum products, kerosene oil and fuel oil. By erroneous quotation and interpolations this was changed to indicate a doubt expressed by this Court as to the immiscibility of these petroleum oils. No such doubt was expressed by this Court, yet the belief of the Circuit Court of Appeals that such a doubt was expressed dominated its entire opinion.

Following these misquotations with unjustified interpolations, the Circuit Court of Appeals correctly quotes the following conclusion stated by this Court, and then, having erroneously stated the premise to that conclusion, erroneously interprets that conclusion, as follows (R., Vol. I, p. 648):

> "This holding is a complete refutation of the statement in the patent in suit (No. 962,678) where it says that the frothing agents of the prior art are only such as are immiscible in water, to wit:

'In the frothing processes hitherto known the substances used to secure the formation of a mineral-bearing froth has been oil or an oily liquid immiscible with water.'

"It is not only a refutation of this statement of the patent in suit but an affirmation of the proposition that 'oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue,' whether immiscible or soluble, or partly immiscible and partly soluble, are frothing agents within the meaning of the disclosure of patent No. 835,120, which is a disclosure of the art prior to the patent in suit."

Obviously this holding was in no way related to the quoted statement of the patent here in suit, in no way refuted it, and in no way affirmed the proposition that soluble mineral-frothing agents are within the ambit of the disclosure of patent No. 835,120. This holding was briefly that the insoluble petroleum products, kerosene oil and fuel oil, were oils within the scope of the claims of patent No. 835,120 and should be counted as such in determining whether the total amount of oil used was greater than a fraction of one per cent. Obviously it assumed that the process disclosed in patent No. 835,120 required the presence in the pulp of an undissolved oily agent which, exercising a preferential affinity for metalliferous matter over gangue, preferentially and selectively coated the metalliferous mineral particles.

This should eliminate patent No. 835,120 as an anticipation of the patent here in suit.

Other errors of the Circuit Court of Appeals in the instant case in interpreting and construing the disclosure of patent No. 835,120.

The principal error in this particular occurs through the mixing up of the subject-matter of the patents prior to patent No. 835,120 with the subject-matter of that patent. By erroneous additions to the disclosures of patent No. 835,120, associated with erroneous interpretations of the actual disclosures of that

patent, that patent is metamorphosed into an anticipation of the process of the patent in suit—into a disclosure of the identical invention of the patent in suit.

The first of these prior patents is the principal Cattermole metal-sinking process patent No. 777,273.

The second of these prior patents is the Cattermole, Sulman & Picard soap and granulation patent No. 777,274, disclosing a useful adjunct to that metal-sinking process.

Finally, the New Zealand patent which, as originally taken out, included both the invention of patent No. 835,120 and the invention of patent No. 777,274, is cited by the Circuit Court of Appeals as the final confirmation in patents prior to the patent in suit of the fact that patent No. 835,120 discloses the identical invention of the patent in suit.

The New Zealand patent and patent No. 835,120 were held by the Circuit Court of Appeals to disclose that there was no difference between the action of undissolved and dissolved mineral-frothing agents. The statement is as follows (R., p. 650):

> "Then again, the disclosure of these two prior art patents,—that agents having a preferential affinity for metalliferous matter coat the mineral particles with a slight film,—is supported by the adsorption theory presented in evidence through defendant's witness Taggart, that such agents, though in solution, will attach themselves to and slightly coat the mineral particles."

What is here meant by "agents having a preferential affinity for metalliferous matter," is dissolved agents that do not and cannot have or exert that preferential affinity, as we have shown above in argument as to the misunderstanding by the Circuit Court of Appeals in the instant case of the phrase "preferential affinity." This appears from the context and from the latter part of the quotation.

We will now consider the several patents that were regarded by the Circuit Court of Appeals as having a bearing on its understanding of the disclosure of 835,120 and confirming same.

CATTERMOLE PATENTS.

These patents are for the metal-sinking process described by this Court in *Minerals Separation, Ltd.* v. *Hyde,* 242 U. S. 261 at 265. The minimum amount of oil used in these processes was 1.8% on the ore, or 36 pounds per ton of ore (Higgins, R., Vol. I, p. 508, XQs563, 564). The function of the oil was to coat the metalliferous mineral with a sufficiently adhesive coating to cause the metalliferous mineral particles, under the contacts brought about by the agitation, to adhere together and form granules which were separated by sinking to the bottom, against an up-current of water.

Patent No. 763,260 of June 21, 1904, Defendant's Exhibit 34 (R., Vol. II, pp. 969-972). The metal-sinking process here disclosed is characterized by the use of an alkaline pulp. It also includes, as do the other Cattermole patents, the use of an emulsifying agent for the purpose of assisting the agitation in breaking up the oil into small globules to be disseminated through the pulp.

This patent is referred to by Professor Taggart as disclosing the use of certain wood or coal tar products (R., Vol. I, p. 189). Obviously the use of these products in this process where the recovery of concentrates was by sinking would not in any manner have informed the art of any possible use of these wood or coal tar products in processes where the recovery of concentrates was by flotation. Flotation of any part of the metalliferous mineral in this metal-sinking process would result in that mineral going to waste with the gangue.

Professor Taggart also quotes from this patent a description of the emulsifying agents, which obviously only perform the function of helping to disseminate thick and insoluble oils through the pulp so that they more readily and uniformly coat the metalliferous mineral particles and cause the particles to adhere together into granules and sink.

Patent No. 777,273, of December 13, 1904, Defendant's Exhibit 35 (R., Vol. II, pp. 973-977). The principal difference between the disclosure of this patent and that of patent No.

763,260, just described, is that an acidified pulp is used in place of the alkaline pulp of that patent. Otherwise its disclosures are substantially the same as in the patent just considered. As this was the principal patent for the Cattermole metal-sinking process, it was referred to in the specification of patent No. 835,120, as this Court says (*Mineral Separation, Ltd.* v. *Butte & Superior*, 250 U. S. 346):

> "to describe the advance which the patentees claimed to have made from the prior art Cattermole agglomeration of metalliferous matter into granules, which separate from the gangue, and sink to the bottom of the pulp under treatment, to the discovery of the patent in suit, with its metal-bearing froth, rising to the surface of the pulp."

Error of the Circuit Court of Appeals for the First Circuit as to this Cattermole Patent.

The Circuit Court of Appeals in the instant case erroneously held that the purpose and effect of the reference to this patent No. 777,273 in patent No. 835,120, was to import into the disclosure of patent No. 835,120 for a froth-flotation process, all of the substances as agents that were disclosed in this Cattermole patent for a metal-sinking process. They said (R., Vol. I, p. 648):

> "Among the oils, fatty acids and other substances having the preferential affinity referred to in patent No. 835,120, are the tar products of the Cattermole prior art patent No. 777,273,"

Of course it does not follow at all that when a patent refers to a prior patent it includes all of the disclosures of that prior patent as a part of its own disclosure, and particularly, as in the present instance, where the reference made is merely to contrast the quantity of "oil" (835,120, p. 1, line 18) or "oleic acid" (p. 1, line 26) and "intended to describe the advance which the patentees claimed to have made from the prior art" as this

Court said in the *Butte* case (250 U. S. at 346). In the Cattermole process everything that floated was wasted. Everything that went into solution was lost and worse than useless. It did not follow at all that everything that was useful in the Cattermole metal-sinking process would be useful in the froth-flotation process. The discovery of the froth-flotation process was made as matter of historical fact by reducing the amount of *oleic acid* in the Cattermole process. The result was a complete reversal of the process and the investigators recognized it as a great discovery and invention. Today, with the knowledge which patent No. 835,120 and the patent in suit both gave to the world, it has been found that certain tar products, which are complex mixtures of substances, may be made to contain substantial quantities of phenols and cresols, so that in their use in froth-flotation ore concentration, the process of patent No. 835,120 and the process of the patent here in suit can be conjointly used with advantage. But this is all after-acquired knowledge—it followed the discovery and invention of the two froth-flotation processes. No one ever used these tar products in carrying on the Cattermole process. No one used these tar products in carrying on the process of patent No. 835,120, no one used these tar products for jointly carrying on the process of patent No. 835,120 and the process of the patent in suit, until long after the discovery and invention of the process in suit.

British patent 26,295 of 1902, Defendant's Exhibit 32 (R., Vol. II, pp. 962-964). This is the first patent for the Cattermole metal-sinking process and is sufficiently described by Professor Taggart (R., Vol. I, p. 188). Apparently defendant refers to it because it mentions a number of oils useful in the Cattermole metal-sinking process and a number of emulsifying agents also useful in that process. Obviously this has nothing to do with mineral-bearing froths.

Patent No. 763,259 of June 21, 1904, Defendant's Exhibit 33 (R., Vol. II, pp. 965-968). This patent is for a supplement to the Cattermole metal-sinking process, a process of breaking down the granules so as to separate out metalliferous minerals therein, as, for example, separating zinc sulphide from lead

sulphide. It does not disclose an ore-concentrating process. Here emulsifying agents are used to remove the oil coatings from the metalliferous mineral particles in the granules of concentrates with which the process starts.

CATTERMOLE, SULMAN AND PICARD PATENTS.

These patents disclose a process of concentrating ores by the employment of a *soluble substance* which, after it has been dissolved and disseminated in the ore pulp, is chemically decomposed therein by the action of an acid so as to form an insoluble substance, which, as it is formed, is precipitated out of solution and coats the metalliferous mineral particles with which it contacts with a sticky or greasy coating, either for the purpose of the Cattermole metal-sinking process, i.e., causing the particles to adhere together upon agitation to form granules which sink, or for the purpose of causing the greased mineral particles to adhere to a greased belt or to greased wood, sawdust or other suitable material lighter than water, or to adhere to gas bubbles to be lifted thereby to the surface to float as a skin float. The process also included the recovery of the insoluble substance from the metalliferous mineral particles, by chemically decomposing it so that it again became a soluble substance. This process was known as the *soap process*. This is the whole of the disclosure of these patents, embodied in two United States patents, included in one British patent and included with the process of patent No. 835,120 in one New Zealand patent. Since the British patent covers the whole subject, it will be first considered.

British patent No. 17,109 of 1903, Defendant's Exhibit 36 (R., Vol. II, pp. 978-981). The part of this specification which the defendant relies upon is included in the following paragraph (p. 979, line 50, p. 980, line 10):

> "In carrying out our invention, the suitably crushed ore is suspended in water, and to the mixture an addition of a small quantity of soap solution is made. A small amount of mineral acid is then added which decomposes the soluble soap or other similar compound

by uniting with the alkaline base thereof, thus liberating in a state of chemical sub-division the fatty or resin acid or other compound such as cresol, etc., in intimate contact with the suspended ore particles. It is found that the liberated acids, etc., which may even be solid under ordinary conditions, are precipitated and adhere to the sulphureted minerals, or to sulphur, graphite, or free metals present in the ore, leaving the gangue or earthy particles preferentially wetted by water, and free from adhesions of fatty acid and the like."

The term "cresol, etc." includes, according to the context, phenol or cresol, and the term "fatty or resin acid" includes oleic acid. Oleic acid is normally a liquid and is wholly insoluble. Phenol is normally a solid and is soluble to a limited extent. Six pounds will dissolve in 100 pounds of water (Bacon, R., Vol. I, p. 347, Q32). Cresol is normally a liquid, and its solubility is one-half that of phenol (Higgins, R., Vol. I, p. 507, XQ557), that is to say, 3 pounds of cresol will dissolve in 100 pounds of water.

The process is dependent upon the coating of the metalliferous minerals with oleic acid or phenol or cresol. All of the oleic acid would be precipitated out and would coat the metalliferous minerals. Only so much of the phenol or cresol as would not dissolve would be precipitated out and would coat the metalliferous mineral (Higgins, R., Vol. I, p. 507, XQs555, 556). The process was far beyond the range of practicability had any attempt ever been made to use it with phenol or cresol. With a 2 to 1 pulp 240 pounds of phenol or 120 pounds of cresol would be dissolved and useless and lost (XQ555). As Mr. Higgins said (pp. 507, 508, XQ561):

> "I am quite sure that it would be more expensive than the process could possibly stand."

Since the process was essentially a granulation process, a normal amount of oleic acid would have been 36 pounds per ton of ore (XQs563, 564). But even as to this the cost was too great and the process was too expensive for use on a large scale (XQ565).

Turning to a consideration of the exact language of this patent above quoted, an effort is made by Professor Taggart to misinterpret the words "chemical sub-division." Professor Taggart interprets this as (R., Vol. I, p. 193, Q6) "in solution in water." What the language means is that the substance is first formed in the finest possible state of division, to wit, as molecules, as the result of a chemical decomposition which is a chemical sub-division of the original molecules and the formation of new molecules. These molecules speedily unite in masses, and if they are not dissolved, they coat the metalliferous mineral particles. Molecules that dissolve are useless in the process. This is well explained by Mr. Higgins (R., Vol. I, pp. 440, 441, Qs136-142). In the case of oleic acid Mr. Higgins describes what takes place: first the formation of a very fine emulsion, and then if given time at rest, the floating to the surface of the little globules of oil (R., Vol. I, pp. 441, 442, Qs143-151).

Professor Taggart in this connection refers to a statement in the so-called Treatise wherein Mr. Sulman describes this invention and says (Deft.'s Ex. 85, R., Vol. I, pp. 192, 193):

> "But by employing the oil in the shape of a soap solution, which may thus be of any desired dilution, and adding this to the acidified pulp, the oil is at once precipitated throughout the pulp mass in a condition of almost molecular fineness, and permits practical uniformity of the oil-coating."

Here Mr. Sulman says that it is precipitated in "almost molecular fineness." As a matter of fact new molecules are formed by chemical sub-division and those that do not dissolve are precipitated throughout the pulp mass. Precipitation is the antithesis of solution.

When this invention was made Mr. Sulman did not know that it was possible to disseminate a much smaller amount of oleic acid than he had ever then dreamed of, to wit, two pounds of oil to the ton of ore, by mere agitation so as to uniformly coat the metalliferous mineral particles. That was not discovered until the process of patent No. 835,120 was invented.

Patent No. 777,274 of December 13, 1904, Defendant's Exhibit 37 (R., Vol. II, pp. 982, 983). This patent is closely limited to the utilization of the soap phenomena in the Cattermole granulation and metal-sinking process. It repeats the disclosure of the British patent as to the soap phenomena and metal-sinking, and those disclosures and the testimony relating to them have been fully considered above. It is specifically referred to in the patent in suit, and the numerous errors in the opinion of the Circuit Court of Appeals in the instant case as to this part of the disclosure of the patent in suit will be considered later (*infra*, p. 99).

It was also referred to in the specification of patent No. 835,120, and here the two references to this patent were carefully confined to the disclosure of oleic acid therein and formed the basis of a description in that patent of the method of producing oleic acid in the pulp by introducing soluble oleic soap and then decomposing the oleic soap with a mineral acid, thereby forming and precipitating insoluble oleic acid so that it would coat the metalliferous mineral particles. It is suggested in patent 835,120 that after the process has been carried on and the oil-covered concentrate recovered, the concentrate may be treated with an alkali to saponify the oleic acid coating the mineral particles, thus again forming soluble oleic soap which may be washed off the particles and again used in a repetition of the froth-flotation process.

As noted above in this process anything that dissolved was useless and anything that floated went to waste with the gangue, since the metalliferous mineral was recovered by sinking the granules formed in the process against an upcurrent strong enough to carry over the gangue or rock particles in suspension in an overflow at the top of the apparatus from which the metalliferous mineral granules were separated at the bottom. If this process had ever been carried on with phenol or cresol (which the evidence indicates was never done and the evidence shows would have been prohibitively expensive) it would have been necessary, first, to provide a sufficient quantity of a phenylate (the alkaline salt of phenol) or a cresylate (the alkaline salt of cresol) to produce, when phenol or cresol were

formed by the decomposition of these alkaline salts, sufficient phenol or cresol to saturate the entire solution (pulp water) and, secondly, above that, to provide sufficient additional phenol or cresol to exercise, when formed and precipitated, a preferential affinity for, and to form a sticky or adhesive coating on, the metalliferous mineral particles. The presence of phenol or cresol in this saturated solution could not, under the conditions of this process, have resulted in the production of a metalliferous-mineral-bearing froth, for the reason that the metalliferous mineral, with its sticky and adhesive coating, would be incapable of attachment to air bubbles and would instead form granules that would sink, and even if any modicum of metalliferous-mineral-bearing froth were formed it would go over at the top to waste with the gangue.

Patent No. 788,247, of April 25, 1905, Defendant's Exhibit 38 (R., Vol. II, pp. 984, 985). This patent discloses the remainder of the disclosure of the British patent. In the absence of any disclosure in this patent of the amount of oil to be used, and in view of its cross-reference to patent No. 777,274 (p. 984, lines 19-23) the only disclosure is of the proportions of oil of the granulation process.

This patent follows a description of the soap phenomena with a general description of all methods of attempted flotation of minerals which were known prior to the invention of the process of patent No. 835,120. First, it describes the Froment method of gas generation by decomposition of carbonic acid (Spec. p. 1, lines 58-75) and then it says (lines 75-84):

> "or the mineral particles may be caused to adhere to metallic or other suitable surfaces coated with similar fatty acids, or, finally, the coated mineral particles may be caused to adhere to wood, sawdust, or other suitable material lighter than water coated with similar fatty acids, &c., which can then be removed by flotation, in each case leaving the mineral-free gangue particles capable of rejection."

This includes the greased belt method and flotation by adherence to wood, sawdust, or other suitable material which has been oil-coated.

The patent does not from beginning to end describe any agitation—indeed the purpose of the invention was to replace the agitation for mixing the oily substance and ore by the diffusion and dissolving of a soluble substance, and then chemically precipitating an insoluble derivative of that substance in a state of fine subdivision to preferentially coat the metalliferous mineral particles. No agitation was required other than a gentle stirring of the pulp to make the solution uniform.

It may be noted at this point that Mr. Higgins testifies to the fact that the soap process of this group of patents has not proved of any practical value (R., Vol. I, p. 442, Q153).

New Zealand Patent No. 19,633.

This patent, of October 27, 1905, is Defendant's Exhibit 55 (specification and drawings as originally issued, R., Vol. II, pp. 1011-1023; amended specification allowed December 11, 1912, pp. 1024-1030). This patent as issued October 27, 1905, included both the froth-flotation process with the minute amount of oil of United States patent No. 835,120 (designated in the marginal note, p. 1011, as "Oleic acid froth") and the soap process of British patent No. 17,109 of 1903 and the other patents just above discussed (designated in the same marginal note, p. 1011, as "Soap"). With the patent as amended on December 11, 1912, we are not concerned. It may be noted, however, that the specification was amended by the elimination of all description of and claims for the soap invention. The soap invention having proved of no practical utility, the patentees in 1912 eliminated it from this patent.

The oleic acid froth process part of this patent specification (R., Vol. II, pp. 1011-1014, pp. 1019, 1020, claims 1-4, p. 1021) adds nothing to the disclosure of patent No. 835,120. The soap process part of this specification (R., Vol. II, pp. 1015-1018, claims 5-9, p. 1022) adds nothing of substance to the disclosures just above considered, but it is of interest that the limits of the proportions of *fatty acid* to be used in this soap process are here stated. The statement is as follows (p. 1016):

> "For example, if the proportion of fatty acid produced in the mixture be about 1% to 4% of the ore and if the mixture be thoroughly agitated, the coated metalliferous particles will adhere together and form granules or small agglomerate masses which, partly by reason of gravity and partly on account of their bulk, as compared with the individual grains of gangue, may be readily separated in up-currents or by other suitable classification apparatus."

And there is the further statement (*ib.*)

> "If however, the proportion of fatty acid be less than 1% of the ore a greater or less proportion of the coated metalliferous matter will form into a froth as described at the beginning of this specification."

i.e., the limits of the soap process are from 4% (80 pounds per ton of ore) down to 1% (20 pounds per ton of ore) of fatty acid and if the proportion of fatty acid be less than 1% the process will be changed to a froth-flotation process. The only fatty acid specified is oleic acid. After the making of the soap invention it was discovered that if the proportion of oleic acid be reduced to less than one percent granulation will be changed to froth flotation. This statement is in exact accordance with the findings of this Court in the *Hyde* case.

The limits in oil proportions of the soap process are, as we have above noted, not specifically set out in the other soap patents, but in this specification, wherein the soap process is juxtaposed with the oleic acid froth process, the patentee was careful to set out these limits in order to clearly differentiate from the froth process.

It is to be remembered that the soap phenomena are described in patent No. 835,120 as capable of application to and use as an accessory of that process when oleic acid is the oil and it is used, as it must be in that process, in a proportion less than one percent of the ore, such use enabling the oleic acid which has coated the metalliferous mineral particles in the concentrate to be saponified by an alkali, and the oleic soap thus formed to be dissolved off by water and used over again in solution, to be decomposed by sulphuric acid to cause precipitation of the

oleic acid so that as an undissolved oil in the pulp it will again coat the metalliferous mineral particles. That this requires the use of less than one per cent of oleic acid is specifically stated in the New Zealand patent which we are now considering. As stated in the New Zealand patent if the proportions of oleic acid were one per cent or more the particles would adhere together and form granules and of course this would prevent the carrying on of a froth-flotation process. The possible utilization of the soap phenomena in froth-flotation when oleic acid was the oil used, was thought to be advantageous and was therefore described in patent No. 835,120, and when the soap invention or inventions (originally devised as an adjunct to the Cattermole process) were included in New Zealand in the same patent with the undissolved-oil froth-flotation invention, the possibility of this utilization was also described, although with clear demarkation of the undissolved-oil froth-flotation process from the earlier soap invention.

The two statements above quoted are followed by the description of methods that may be employed for lifting to the surface mineral particles that have been coated according to the soap process, i.e., with from 1% to 4% of a fatty acid such an oleic acid. These are the methods of attempted flotation which preceded the invention of the process of Patent No. 835,120, and have been described above in connection with the Cattermole, Sulman and Picard soap and flotation U. S. patent No. 788,247 (*supra*, p. 92).

It is to be noted that all the descriptive matter above quoted is limited to fatty acids which will coat the metalliferous mineral particles. The references to phenol and cresol are general and with no proportions given, but the soap invention required that they should be present in such amounts that, when liberated from their salts, there would be such an excess above their solubility limit as would provide the metalliferous mineral particles with adhesive coatings such as to enable these particles to adhere together or to adhere to oil-coated belts, sawdust, etc.

The impossible extravagance of using phenol or cresol in this soap process may or may not have been appreciated by the

inventors. The fact that the actual amounts of a fatty acid such as oleic acid are given, and no actual amounts of the phenol and cresol are anywhere stated, and the fact that Mr. Chapman, who was in the Sulman & Picard laboratory at the time of this invention (from September, 1899, to April, 1904, R., Vol. I, p. 597) knew nothing about any work with phenol or cresol (R., Vol. I, pp. 387, 388, Qs52, 53) and that Mr. Higgins who tested and investigated the Cattermole process from December, 1903, until it was dropped in March, 1905, knew nothing of any use of phenol or cresol in connection with the Cattermole process (R., Vol. I, p. 531, RDQ715), would indicate that the suggestion in these specifications of the use of phenol or cresol to coat metalliferous mineral particles and produce such coatings thereon as would enable the particles to adhere together or to adhere to oil-coated belts, etc., was a mere shot in the dark.

This New Zealand patent was not referred to in the testimony. It was merely offered in evidence at page 176 as one of a great number of prior documents. Thereupon defendant's expert, Professor Taggart commenced his testimony in explanation of prior documents. In that testimony he did not advert to this patent, and defendant's counsel did not call it to his attention. Therefore it was not deemed necessary to refer to it in plaintiff's rebuttal testimony.

Defendant's counsel appear to have discovered its supposed importance since the trial. They have evolved a misreading and a misinterpretation of this patent which are wholly unjustified, but which have been adopted by the Circuit Court of Appeals for the First Circuit in their opinion in the instant case. The opportunity for this misreading and misinterpretation of the New Zealand patent was afforded by the fact that the earlier soap invention and the later oil-froth-flotation invention and discovery were, for reasons merely of economy, both included in one specification in the New Zealand patent as originally taken out. The soap invention was the subject of one British patent, No. 17109 of 1903, but in the United States it had to be divided into two patents—one for soap and granulation (777,274, Cattermole, Sulman & Picard), and the other for soap and such efforts at flotation as preceded the discovery

of the oil-froth-flotation process (788,247, Cattermole, Sulman & Picard). The oil-froth-flotation process was the subject of patent No. 835,120. It may therefore be said in comparing the New Zealand patent with the United States patents that it was taken out for three inventions, since its subject-matter had to be included in three United States patents. All of these United States patents were before this Court in the *Hyde* and *Butte & Superior* cases.

Although the three inventions are described in one document, they are separately described and separately claimed. It requires only intelligent reading to separate out these three inventions (1) soap and granulation, (2) soap and skin flotation, and (3) oil-froth flotation. The two soap inventions first named are closely related, differing only in what is done with the metalliferous mineral particles *after they have been coated* with sticky or adhesive coatings, i. e., in the first they are granulated and sunk, and in the second they are raised to the surface either by causing them to adhere to metallic or other suitable surfaces (such as belts) coated with similar substances, or causing them to adhere to wood, sawdust or other suitable material lighter than water when these materials are also coated with similar substances, or causing them to be attached to chemically generated gas bubbles and lifted to the surface where it is hoped they will float as a skin float.

The mere juxtaposition of descriptions of the inventions of the three American patents specified above in one New Zealand patent adds nothing to the effectiveness of the separate disclosures of the separate American patents as anticipations of the patent in suit.

Errors of the Circuit Court of Appeals for the First Circuit as to the New Zealand patent.

The errors of the Circuit Court of Appeals in their interpretation of this three-invention New Zealand patent appear to have been principally founded upon the false chemical notion that phenol and cresol are derivatives of fatty acids, an error which appears three times in their decision (*infra*, p. 104). The

clear statement above quoted that if "the proportion of fatty acid be less than 1% of the ore * * * the coated metalliferous matter will form into a froth" is quoted by them with an error only in that "fatty acid" is pluralized into "fatty acids" (R., Vol. I, p. 650). Then they say (*id.*):

> "The words 'fatty acids' as used in that paragraph referred back to the group of fatty acids and their derivatives cresol and phenol previously mentioned."

Here the errors are (1) that "fatty acid" has been misquoted as "fatty acids," and (2) the statement that cresol and phenol are derivatives of fatty acids. Both statements are precisely wrong. The word "fatty acid" refers to only one fatty acid. It refers back to the only fatty acid previously disclosed, to wit, oleic acid; but even if it were plural and referred to a group, it could not by any possibility refer to cresol and phenol which are not fatty acids and which are not derivatives of fatty acids. Then follows the conclusion from these errors (*ib.*):

> "and plainly disclose that phenol is one of the frothing agents described in and made a part of patent No. 835,120; and if used in the fraction of 1% on the ore, the critical amount of the patent, the metalliferous matter will be coated and the froth formed."

Instead of plainly disclosing that phenol is one of the frothing agents described in and made part of patent No. 835,120, this language merely discloses that if oleic acid be used in a proportion of less than 1% on the ore, the process of granulation will be changed to froth flotation. Of course if that is done the metalliferous matter will be coated with oleic acid and a froth will be formed of the oleic-acid-coated metalliferous matter. But if phenol were used in the critical amount of patent No. 835,120, it would be completely dissolved, the metalliferous matter would not be coated at all, and the process of patent No. 835,120 could not be carried out. There would be froth formation but it would be a different froth achieved on a different principle and by a different process which involved neither preferential affinity for, nor any coating of, the mineral par-

ticles. If any one had done this ignorantly it would have been a mere accident. If anyone had done it intelligently he would have known that it could not be the process of 835,120 and that a new process had emerged. Nobody as matter of fact did it at that time either ignorantly or intelligently.

The Circuit Court of Appeals refer to the New Zealand patent as confirming their construction of patent No. 835,120, as disclosing the use of phenol as a frothing agent—a wholly unjustified construction of that patent. They also refer to it as confirming their erroneous adoption of the "adsorption theory" put forward by defendant's witness, Taggart, to wit, that mineral-frothing agents which have been completely dissolved in the water of a pulp, come out of solution and coat the metalliferous mineral particles in the process of the patent in suit. As we have heretofore shown, this adsorption theory is completely disproved by the facts (*supra*, p. 64). Both this construction and this theory are completely disproved by the record. The New Zealand patent in its juxtaposition of the subject-matter of three United States patents clearly distinguishes and delimits each invention from the other, and its description, when properly understood, is helpful in this delimitation. It utterly fails to support either the construction stated of patent No. 835,120 or the adsorption theory of Prof. Taggart.

Errors of the Circuit Court of Appeals in the instant case in interpreting statements of the Patent in suit relative to prior patents and processes.

The statement as to prior processes in the specification of 962,678 commences as follows (Spec. p. 2, lines 17-20):

> "Hitherto many proposals have been made for the wet concentration of ores involving the addition to the liquid in which the ore is suspended of an immiscible liquid."

This is erroneously interpreted by the Circuit Court of Appeals in the instant case, the quotation of the above sentence being preceded by the following statement (R., Vol. I, p. 642):

> "In attempting to differentiate the mineral-frothing agents of the patent which it discloses as being in solution, from the mineral-frothing agents of the prior art used in the concentration of ores, the patentees state:"

This statement is quite erroneous.

First Error: What the patentees primarily refer to are prior *processes* and not *agents*.

Second Error: The only prior processes referred to wherein a mineral-bearing froth was formed are the process of patent No. 835,120 and of a few unimportant related patents. Therefore, these were the only prior processes wherein a mineral-frothing agent was used. The agents disclosed in the patents describing these processes were immiscible substances which preferentially coated the metalliferous mineral particles and did not coat the gangue particles; and the processes operated by reason of forces that came into play as a result of the fact that the metalliferous particles were coated with oil and that the gangue particles were not coated with oil.

Third Error: The first of the prior processes referred to not only was not a froth-flotation process, but it was not even a flotation process. It was the antithesis of a flotation process. It was a metal-sinking process, in which recovery of the metalliferous mineral was effected by sinking it, and everything that floated went to waste. So completely was this prior process misunderstood by the Circuit Court of Appeals in the instant case, that they called it a "flotation process" as will appear.

This prior metal-sinking process first specifically referred to is identified and quite fully described in the specification of the patent in suit, as follows (Spec. p. 2, lines 20-31):

> "For example, in the patent granted to Cattermole, Sulman & Picard, United States No. 777,274, dated December 13th, 1904, is described a process of ore concentration in which metalliferous particles were coated with a thin film of a fatty or resin acid or a phenol or a cresol by introducing the alkaline compounds of these

materials into an acid liquid whereby these materials were liberated in an immiscible or insoluble condition and adhered to the mineral particles."

That patent is known as the soap and granulation patent. It may be noted here that the patent in suit accurately states as to that patent that it disclosed the liberation from other compounds, by chemical decomposition of those compounds, of a phenol or a cresol, or a fatty acid such as oleic acid, or a resin acid, "in an immiscible or insoluble condition" and so that it "adhered to the mineral particles" (Spec., p. 2, lines 29-31) with the result that the "metalliferous particles were coated with a thin film of a fatty or resin acid or a phenol or a cresol" (Spec., p. 2, lines 25-27). It may be also noted that the process of that patent required that this coating film of phenol or cresol, or fatty or resin acid, should be such a coating as would cause the coated metalliferous particles to adhere or stick together into granules (and not adhere to air bubbles) and that they should be recovered by a sinking operation (and not by flotation).

The process described in that Cattermole, Sulman & Picard patent No. 777,274, is, as above noted, a metal-sinking process wherein the only recovery of metalliferous mineral is of the particles that sink, and wherein any metalliferous mineral particles that floated would flow off with the tailings and be lost.

This Court in the *Hyde* case referred as follows to that class of process and to the companion Cattermole patent No. 777,273 (242 U. S. 261):

> "The process of the other class, called in the record the 'Metal Sinking Process,' reverses the action of the Surface Flotation Process and is illustrated by the Cattermole U. S. patent, No. 777,273 * * *.
>
> "It is obvious that the process of the patent in suit [835,120], as we have described it, is not of the Metal Sinking class, * * *."

Patent No. 777,274 was before this Court in the *Hyde* case and was another illustration of this metal-sinking process.

Yet in the opinion of the Circuit Court of Appeals for the First Circuit in the instant case it is said, referring to the

process of Cattermole, Sulman & Picard patent No. 777,274 (R., Vol. I, p. 642):

> "That process is known as the skin flotation process."

This error shows a complete misunderstanding of the disclosures of this prior patent.

Then follows in the opinion this statement, referring to that same patent No. 777,274 (*ib.*):

> "Its specification discloses that the fatty or resin acids, or their derivatives cresol and phenol, are soluble compounds and that the improvement of that patent consisted in the method of thoroughly dispersing these compounds, due to their solubility, throughout the pulp in admixture with the mineral particles suspended in the ore mass; that when thus disseminated a small amount of mineral acid is added which decomposes the compound used, thus liberating the compound in intimate contact with the mineral particles which adhere thereto."

This description contains at least three outstanding errors.

First Error. The prior specification referred to does not disclose that the fatty and resin acids and phenol and cresol are soluble compounds. Its disclosure is quite to the contrary. There is no thought of utilization of solubility in any part of this prior specification as applied to these substances, nor is there any possibility of the utilization of solubility of these substances in the process of this prior patent. Any portion of these substances which dissolved would be useless in the process. The functioning of the process is dependent upon insolubility of the fatty and resin acids and phenol and cresol. The patent provides a method of chemically producing these substances *in situ* in the pulp from soluble substances (soaps or salts) which have been introduced into the pulp and readily diffused therein by reason of their solubility, and the purpose of the process is to liberate *in situ* fatty or resin acids or phenol or cresol "in an immiscible or insoluble condition." A soap of a fatty or resin acid, or the soluble alkaline salt of cresol or

phenol (a cresylate or a phenylate) is introduced into the pulp and dissolved in the water of the pulp and when dissolved may be easily diffused uniformly through the pulp. Then by chemical action, to wit, the decomposing action of sulphuric acid, the fatty or resin soap or the phenylate or cresylate is decomposed and thereby the fatty or resin acid or phenol or cresol is formed *in situ* and is precipitated from solution in a state of very fine subdivision and "in an immiscible or insoluble condition" and preferentially and selectively coats the metalliferous mineral particles and forms upon these particles a sticky or adhesive coating, and the metalliferous mineral particles, thus covered with the sticky or adhesive coating of fatty or resin acid or phenol or cresol, are caused by the agitation to contact and to adhere together in small masses or granules which are later separated from the gangue particles by sinking them in an up-current of water strong enough to carry away to waste the gangue particles and with them everything that floats or tends to float. While the fatty and resin acids are completely insoluble substances, phenol and cresol have a limited solubility. Six pounds of phenol will dissolve in one hundred pounds of water (R., Vol. I, p. 347, Bacon, Q32). Therefore, in this process a definite excess over and above 6 pounds of phenol must be used for every 100 pounds of water and such excess above the 6 pounds is available and is utilized in the coating process and the 6 pounds per 100 pounds of water is dissolved away and lost to the process. The solubility of cresol is one-half that of phenol (R., Vol. I, p. 507, Higgins, XQ557), so a definite excess over and above 3 pounds of cresol must be used for every 100 pounds of water and all such excess over the 3 pounds is available and is utilized and the 3 pounds per 100 pounds of water dissolved away and lost to the process.

The Circuit Court of Appeals in the instant case has simply confused the soaps or salts which were put into the pulp and which wholly dissolved and were therefore powerless to coat anything, with the agents themselves which were produced by the chemical decomposition of these soaps or salts and which functioned solely by reason of insolubility and coating.

The second error in the above quotation is the statement that cresol and phenol are derivatives of the fatty or resin acids. They are not. In the process the fatty and resin acids are derivatives of their own soaps, since they are formed by chemical action from solutions of their soaps. The phenol and cresol are derivatives of their soluble salts (phenylates and cresylates) since they are formed by chemical action from solutions of these soluble salts.

This curious error of describing cresol and phenol as derivatives of the fatty and resin acids appears three times in the opinion of the Circuit Court of Appeals for the First Circuit. In addition to the statement above quoted at page 642, it appears again at page 648 near the bottom of the page, and appears again at page 650 at the beginning of the third paragraph. The erroneous notion that cresol and phenol are derivatives of fatty acids appears to some extent to account for the erroneous view that phenol is disclosed in patent No. 835,120 as one of the frothing agents of that patent, which might be called the basic concrete error of the opinion.

Returning to the above quoted first reference in the opinion relative to patent No. 777,274, *the third error* therein is the statement that "the improvement of that patent consisted in the method of thoroughly dispersing these compounds, due to their solubility, throughout the pulp in admixture with the mineral particles suspended in the ore mass." The error here is that the compounds are not dispersed "due to their solubility," but they are dispersed due to the solubility of other compounds—their soaps or salts—from which they are afterward derived by chemical decomposition. The process starts with the soap of a fatty or resin acid, or with a phenylate or a cresylate. These substances are readily soluble and they are easily dispersed through the pulp. After the soap or the phenylate or the cresylate has been thus dissolved and dispersed throughout the water of the pulp, it is decomposed by sulphuric acid and the fatty acid or the resin acid or phenol or cresol is formed and precipitated from solution, and preferentially and selectively coats the metalliferous mineral particles with which its undissolved

particles or globules are brought into contact. In the case of a fatty or a resin acid all of it is precipitated and coats the metalliferous particles; in the case of phenol or cresol, only that part of it is precipitated and coats the metalliferous particles which does not go into solution, and only that part of it which does not go into solution performs any useful function in this Cattermole metal-sinking process.

The concluding portion of the above quotation is the statement that, when a small amount of mineral acid is added, it "decomposes the compound used, thus liberating the compound in intimate contact with the mineral particles which adhere thereto." This shows again the utter confusion in the mind of the Court of "the compound used" (the soluble soap or salt) with "the compound which adheres" to "the mineral particles" (the insoluble fatty acid, etc.).

Then in the patent in suit there is a reference to "another known process" (Spec., p. 2, l. 32) which is described as a film-flotation process not employing oil, wherein "the powdered ore suspended in water, preferably acidified, is mechanically brought to the surface whereby the particles are exposed to the air" (Spec., p. 2, ll. 32-35). This is the attempted flotation of unoiled metalliferous mineral particles like wood chips on the surface of water. This known process is so remote from the process of the patent in suit that the defendant did not put in any evidence describing it.

Although this process is quite fully described in the patent in suit, the Circuit Court of Appeals for the First Circuit in the instant case failed to comprehend the description and said (R., Vol. I, p. 642):

> "The specification then refers to another prior art flotation process but does not specify the agent employed."

First, this is not "*another* prior flotation process" since the process just previously described was not a flotation process at all, and second, the only agent employed, to wit, a soluble acid, such as sulphuric acid, is at least indicated in the statement that the water is acidified.

It may be further added that this prior flotation process, depending for flotation upon "the properties of the metalliferous particles themselves when exposed to air or other gas and brought onto the edge or surface of water preferably acidified" (Spec., p. 2, ll. 42-46) and "mechanically brought to the surface whereby the particles are exposed to the air" (Spec., p. 2, ll. 34, 35) is properly describable by the term "skin flotation process" which the Circuit Court of Appeals for the First Circuit erroneously used to describe the metal-sinking process of the Cattermole, Sulman & Picard patent No. 777,274.

It may be noted that the patentees have in the paragraph above referred to (Spec., p. 2, ll. 17-46) given an example of a metal-sinking process utilizing adhesively coated mineral particles, and of a film-flotation process not utilizing oil coatings. They then proceed to point out (Spec., p. 2, ll. 53-57) that their present process differs from these and other known processes by the use of a "mineral-frothing agent in solution" and by the fact that the metalliferous particles are brought to the surface in the form of a froth or scum, "not by mechanical means but by the attachment of air or other gas bubbles thereto."

Then follows the statement (Spec., p. 2, ll. 58-61):

> "In the frothing processes hitherto known the substances used to secure the formation of a mineral-bearing froth has been oil or an oily liquid *immiscible with water.*"

These priorly known frothing processes are that of patent No. 835,120 and such suggested variations thereof as appear, for example, in the superaeration patent No. 835,479 to Sulman, Picard & Ballot of Nov. 6, 1906, and the boiling patent No. 835,143 to Sulman of November 6, 1906, in so far as carried out with the minimum amount of oil characterizing the process of patent No. 835,120. This statement of the patent in suit is precise, accurate and truthful. The Circuit Court of Appeals for the First Circuit, however, quotes it and says that it is completely refuted by the opinion of this Court in the *Butte & Superior* case (R., Vol. I. p. 648), basing its conclusion upon errors in quoting the opinion of this Court and unjustified interpolations therein completely changing the meaning of the language used. We have treated of this at page 80, *supra*.

Errors of the Circuit Court of Appeals for the First Circuit in the instant case relative to the disclaimer in the patent in suit.

The disclaimer appears at page 2, lines 69-77 and is as follows:

> "It is well known that certain of the organic substances we have referred to are not soluble in water in all proportions and that if used in excess might partly remain insoluble in the acidified water and might become mechanically affixed to the metalliferous particles of the ore. We disclaim any such use of these substances and only claim them in such amount as will enable them to dissolve in the acidified water."

This disclaimer merely accentuates the affirmative disclosures of the specification that the process is one employing mineral-frothing agents in solution. Obviously even the same physical substance if used under conditions which prevent its going into solution cannot function as a part of the process disclosed and patented.

Defendant's process employs as the only mineral-frothing agent a substance which completely dissolves in the water of the pulp. As is shown hereinafter (*Infra,* p. 129), defendant uses such a small proportion of this agent (alpha-naphthylamine or X-cake) that the amount used is only one thirty-fourth of the amount that would wholly dissolve in the water of defendant's pulp. This disclaimer, therefore, however interpreted and applied, cannot relieve the present defendant from infringement.

Nevertheless there has been much contention here as to the meaning of the disclaimer by reason of the fact that in many instances of the use of the invention of the patent in suit in the practical art there has been a conjoint use of the process of patent No. 835,120 (involving an undissolved mineral-frothing agent) and of the process of the patent in suit (involving a mineral-frothing agent in solution). This was the situation in the *Miami case* and there both patents were held to be infringed. But in no instance in the art has a froth-flota-

tion process been practiced wherein soluble substances were used as mineral-frothing agents in quantity in excess of their solubility or under conditions which prevented their going wholly into solution. Consequently the conditions set out in the disclaimer have never been met in practice at any time either before or since the issue of the patent in suit. Pine oil may be taken as an example of a complex mixture of substances including both classes of mineral-frothing agents. The fact that it is "a mixture of a lot of different chemical compounds" of variable content depending upon the process of manufacture, was stated by defendant's expert, Professor Taggart (R., Vol. I, pp. 219-220, Q58). As Mr. Higgins testifies (R., Vol. I, p. 491, XQ461):

> "A. Pine Oil contains a mixture of a good many substances—chemical substances—several of which are soluble and others insoluble. Both are mineral-frothing agents."

Therefore, the use of this complex manufactured mixture of substances in a froth-flotation process involves the use both of an insoluble mineral-frothing agent and of a soluble mineral-frothing agent, in which the process of patent No. 835,120 and the process of the patent in suit are conjointly used, or, as Mr. Higgins testifies, it involves "the use of the patent in suit, together with the use of the process of patent No. 835,120."

This conjoint use of the two processes has been found to be highly beneficial—better for some ores than either process alone. Neither process hinders or prevents the other process. Apparently each helps the other. This is clearly not the thing disclaimed in the patent in suit. It does not involve the use of a soluble mineral-frothing agent in a quantity in excess of its solubility. Therefore, the disclaimer, however interpreted, cannot apply to such a conjoint use of the two processes.

The errors and confusion of the Circuit Court of Appeals for the First Circuit in regard to this matter probably arose from considering pine oil as a single substance, notwithstanding the positive testimony in behalf of both parties to the contrary. That particular error might have been unimportant had

it not entered into the misunderstanding and misconstruction by the Circuit Court of Appeals of the First Circuit of the decision of this Court in the *Butte & Superior* case.

Other errors of the Circuit Court of Appeals in the instant case in interpreting the patent in suit.

Prior patent No. 835,120 for a process of froth-flotation employing undissolved mineral-frothing agents, gives a general definition of substances which may be used in that process as

> "oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue."

The Circuit Court of Appeals reaches the conclusion that many of the substances named in the patent in suit as mineral-frothing agents in solution are included within this definition of patent No. 835,120.

But this is error.

Any substance, in order to exercise this preferential affinity, must remain undissolved in the water of the pulp in the form of particles or globules disseminated through the pulp and repelled by the water so that they escape from the water to the surface of the metalliferous particles and coat them. This old and well-known quality of oils was utilized in the process of patent No. 835,120, and where the oil globules were present in such small amount that the resultant coating of metalliferous mineral particles would not cause those particles to adhere together and form granules but would cause them to adhere to air bubbles and form froth, the process of patent No. 835,120 would be carried on.

On the other hand a typical example of a soluble mineral-frothing agent of the process of the patent in suit is acetic acid or vinegar, and its qualities in the presence of water as contrasted with oily substances are well-known. It is soluble in all proportions in water (Higgins, R., Vol. I, pp. 530-531, RDQs709-712), so that in whatever quantity used it completely dissolves.

The patent in suit gives as examples of substances which will act as mineral-frothing agents in solution (R., Vol. II, p. 664, Spec., p. 1, ll. 33-36):

> "amyl acetate and other esters; phenol and its homologue; benzoic, valerianic and lactic acids; acetones and other ketones such as camphor."

These are all substances which in the small proportions specified in the patent in suit, are completely dissolved and cannot function to coat the mineral particles preferentially as do the undissolved oil globules of patent No. 835,120. Specimens are in evidence of amyl acetate (Plaintiff's Exhibit 22), its solution in water (Plaintiff's Exhibit 27), phenol (Plaintiff's Exhibit 23), its solution in water (Plaintiff's Exhibit 28), benzoic acid (Plaintiff's Exhibit 24), its solution in water (Plaintiff's Exhibit 29), lactic acid (Plaintiff's Exhibit 25), its solution in water (Plaintiff's Exhibit 30), and camphor (Plaintiff's Exhibit 26) and its solution in water (Plaintiff's Exhibit 31). These solutions are all in the proportions specified in the patent in suit.

The Court will see that amyl acetate is a colorless liquid not oily at all, and that it gives a clear and brilliant solution. When a bottle of amyl acetate (Plaintiff's Exhibit 22) is shaken a few large bubbles are entrapped (Higgins, R., Vol. I, p. 547, RDQ773). When its solution (Plaintiff's Exhibit 27) is shaken, if there be also air in the bottle, there is a tremendous development of bubbles and they are exceedingly fine bubbles (p. 548, RDQ774).

It happens that amyl acetate is known in commerce as banana oil, just as sulphuric acid is known as oil of vitriol. Neither of them are oils in the sense of patent No. 835,120. A trade name cannot change the nature of a substance. Yet the Circuit Court of Appeals apparently thinks that it can.

Amyl alchohol is a substance not specifically named in the patent in suit, but it is an amyl compound which is a mineral-frothing agent in solution within the scope of the claims in issue. As Professor Taggart states (R., Vol. I, p. 241, Q117) "fusel oil contains amyl alcohol."—that is, amyl alcohol is one

of the constituents of fusel oil. Obviously it is not proved to be an oil by proving that it is a constituent of the substance commercially known as "fusel oil."

The Circuit Court of Appeals says as to these two substances (R., Vol. I, p. 649):

> "Amyl acetate known in commerce as banana oil, and amyl alcohol commonly known as fusel oil, both of which are specifically mentioned as mineral-frothing agents in the patent in suit (962,678), have a preferential affinity for metalliferous matter and are undoubtedly oils of the prior art. Amyl acetate is soluble in water in the proportions used of a fraction of one per cent on the ore."

In other words, because amyl acetate is known in commerce as banana oil, and notwithstanding the fact that when used in the proportion of a fraction of one percent on the ore it would be completely dissolved, the Circuit Court of Appeals classifies it as one of the oils of patent No. 835,120 having "a preferential affinity for metalliferous matter." This is clear error. Not only is it not disclosed or referred to in patent No. 835,120, but it utterly fails to come within the broad definition of substances which may be considered as "oils of the patent" having a preferential affinity for metalliferous matter. Its use in the water of an ore pulp does not result in the presence in that water of any undissolved oil globules. It does not by reason of repulsion of water and preferential affinity for metalliferous particles selectively coat the metalliferous mineral particles in an ore pulp. The same is true as to amyl alcohol, which is not "specifically mentioned" in the patent in suit.

Valerianic acid is admittedly completely soluble in water in the proportions used in flotation. Although it may be chemically classed as a fatty acid, it has none of the qualities of the fatty acids which were used in the prior flotation art and which were essentially saponifiable fatty acids, such as oleic acid, the single example in patent No. 835,120. Oleic acid is physically an oil, is insoluble in all proportions, is derived from fats and is capable of being chemically changed by an alkali into a soap which will dissolve in water, this soap being capable in turn

of being decomposed by an acid so as to liberate again the insoluble oleic acid but now in a state of fine division disseminated throughout the water of the pulp and ready to be forced upon the metalliferous particles by its repulsion by water and its preferential affinity for these particles. This is the soap phenomenon of Cattermole, Sulman & Picard patent No. 777,274 (see *supra*, p. 91). Obviously valerianic acid is not within the category of the fatty acids of patent No. 835,120 and the prior art, and obviously also by reason of the fact that it completely dissolves in the proportions used in flotation it cannot be present in the solution in the form of undissolved globules to preferentially coat the metalliferous mineral particles. Yet, as to this substance, completely soluble when used, the Circuit Court of Appeals says (R., Vol. I, p. 649):

> "Valerianic acid is a soluble mineral-frothing agent specifically named in the patent in suit and is a fatty acid of the prior art patents Nos. 835,120 and 777,274."

This was clear error.

Benzoic acid is a white, crystalline solid, flaky in appearance (Higgins, R., Vol. I, p. 548, RDQ776). A specimen is in evidence as Plaintiff's Exhibit 24, as well as a clear and brilliant solution of it in froth-flotation proportions (Plaintiff's Exhibit 29). Being completely soluble, it does not have preferential affinity for, nor can it coat, the metalliferous material in an ore pulp. Although a solid substance, it is said to be chemically a resin acid, but obviously it is not such a resin acid as the prior art patent to Cattermole, Sulman & Picard No. 777,274 mentions, since that disclosure requires a saponifiable resin acid, i. e., one capable of being made into a soluble soap by the action of alkali. Yet, as to this solid substance, completely dissolved when used, the Circuit Court of Appeals says (R., Vol. I, p. 649):

> "Benzoic acid is also one of the soluble mineral-frothing agents specifically mentioned in the patent in suit. It has a preferential affinity for metalliferous matter over gangue and is therefore included within the terms referred to in patent No. 835,120 as 'other substances' and

is also included among the resin acids of Cattermole 777,274."

This was clear error.

Phenol is named as a mineral-frothing agent in solution in the patent in suit, and the term "its homologues" includes cresol. Phenol is a normally solid substance familiar in a solution known as carbolic acid. A specimen of it is in evidence (Plaintiff's Exhibit 23), as well as its clear and brilliant solution in water in the proportions specified in the patent in suit (Plaintiff's Exhibit 28). Although in the proportions used it completely dissolves, it has only a limited solubility and it is mentioned in the Cattermole, Sulman & Picard patent No. 777,274 as useful to coat metalliferous mineral particles in an ore pulp so as to provide an adhesive coating which will enable them to be rolled up into granules and separated by sinking. Its use for such purpose involves the useless dissolving of a certain amount of it, up to the point of saturation, and it is only above that point that its undissolved portion is useful in this granulation process. The same is true as to cresol, except that it is only one-half as soluble as phenol and, therefore, less of it would be required and more of it would be useful if anyone were to use it in the Cattermole granulation process. Neither of these substances is referred to in patent No. 835,120, and if used in the proportions of that patent they would go completely into solution and would have no preferential affinity for metalliferous matter over gangue whatever and could not carry out the process of that patent. They are, therefore, when so used not among the oils or oily liquids or other substances of that patent as they have been defined by this Court. This has heretofore been considered, but it may be noted here that the patent in suit very clearly differentiates from the prior disclosure in patent No. 777,274 of the use of undissolved phenol or cresol for coating metalliferous mineral particles in an ore pulp so as to permit granulation of the adhesively coated particles. As to these substances the Circuit Court of Appeals said (R., Vol. I, p. 649):

> "Phenol and cresol named or referred to as soluble mineral-frothing agents in the patent in suit are specifically

named in the prior art patent of Cattermole (777,274) and are among the oils or oily liquids of patent No. 835,120."

This is clear error.

This is followed by a statement of the conclusion that as phenol is one of the oils or oily liquids of patent No. 835,120 (although it is not therein mentioned or referred to) that patent, No. 835,120, anticipates the patent in suit.

Error of the Circuit Court of Appeals in the instant case in regard to the Conjoint Use of the Process of Patent No. 835,120 and of the process of the Patent in Suit.

In the *Miami* case as aforesaid the Circuit Court of Appeals for the Third Circuit found that these two processes were conjointly used by the defendant there, and held such conjoint use to be an infringement of both patents.

This conjoint use may be well illustrated by the use of the complex material known as pine oil as a mineral-frothing agent in a process of ore concentration. Pine oil is made up in part of substances—chemical compounds—that do not dissolve in the water of the pulp and so are adapted to preferentially coat the metalliferous mineral particles, and in part of substances —chemical compounds—that do dissolve in the water of the pulp and so are unable to coat anything in the pulp. The substances that do not dissolve are oily mineral-frothing agents and clearly are oils of patent No. 835,120 for they have a preferential affinity for the metalliferous mineral particles. The substances that do dissolve act as mineral-frothing agents in solution and are within the scope of the claims in issue. They are not used in excess of their solubility and therefore their use is clearly not the thing disclaimed in the patent in suit. If these two classes of substances constituting pine oil were separated and those of either class were used alone, they would achieve a froth-flotation process, the one by the principle of operation of patent No. 835,120 (if used in sufficiently small quantity) and the other by the principle of operation

of the patent here in suit. When the complex material is used without separation into its two classes of constituent substances, it has been found that neither impairs the operation of the other but that the conjoint use of both classes of substances is advantageous.

Defendant in the present case carries on only the process of the patent in suit. Defendant's mineral-frothing agent is the single chemical substance alpha-naphthylamine which goes completely into solution in the operation of defendant's process and is used in a quantity far below the saturation point.

The defendant brought out in its evidence the complex nature of the material known as pine oil (Taggart, R., Vol. I, pp. 219, 220, Q58) and in the cross-examination of Mr. Higgins brought out the character and quality of the constituent substances of this complex material (R., Vol. I, p. 491, XQ461), and the evidence as to commercial use of the process of the patent here in suit shows a large conjoint use of the two processes from 1912 on in the employment of pine oil and the various creosotes and tars by many of plaintiff's licensees (R., Vol. II, pp. 695, 712).

The Circuit Court of Appeals in the instant case, after discussing the disclaimer in the patent in suit, says (R., Vol. I, p. 644):

> "But in this case (see R., Vol. I, pp. 492, 503) and elsewhere the plaintiffs have contended for a broader construction or scope of the patent and have claimed that organic compounds partly immiscible and partly soluble in water were within the scope of the patent and that such use was an infringement; and apparently they have obtained a decision to that effect in *Miami Copper Co.* v. *Minerals Separation, Limited*, 244 Fed. 752, on the ground that the use of an oil that went in part into solution, the balance remaining immiscible, was a conjoint use of the patent in suit and of patent No. 835,120, if the immiscible part was used in a fraction of one per cent on the ore. We do not now stop to consider the soundness of this contention and holding, for it is not directly involved in this case, although it will be considered later."

The "contention and holding" as to conjoint use of the two processes "is not directly involved in this case" as the Circuit

Court of Appeals says, because the defendant here does not use a complex mixture of substances some constituent parts of which are soluble and some insoluble (as in the *Miami* case) but uses a simple substance that is wholly soluble.

The record references in the above quotation are significant because they indicate the confusion of mind of the Circuit Court of Appeals in this matter. The references are to the cross-examination of plaintiff's expert witness Mr. Higgins. The first reference is to R., Vol. I, p. 492, wherein he was asked for his opinion as to the use of phenol in the process in excess of its solubility, and expressed the opinion that if it were thus used and the amount of it in excess of its solubility were less than one per cent of the weight of the ore, that would be a conjoint practice of the process of patent No. 835,120 and of the process of the patent here in suit. This record reference betrays confusion of thought in the matter for that was not what the defendant in the *Miami* case used or what the Circuit Court of Appeals for the Third Circuit referred to as conjoint use. It also appears that such use of phenol would require in excess of 500 pounds (one quarter of a ton) to the ton of ore (Higgins, R., Vol. I, p. 507, XQ559). Since no one ever used phenol in anything approaching these proportions, the question is purely academic. No question of that character has ever arisen or can ever arise in the construction of the patent in suit.

The second of these references (R., Vol. I, p. 503) is to the cross-examination of Mr. Higgins wherein there is an indefinite reference to the use of an agent a constituent of which is a mineral-frothing agent in solution, the other constituents of which remain undissolved in the ore pulp. So far as developed this would appear to be parallel to the use of a complex agent such as pine oil wherein, as above stated, certain constituents or chemical compounds act as mineral-frothing agents in solution and the other constituents or chemical compounds act as oils of patent No. 835,120, and none of the constituents or compounds that are mineral-frothing agents in solution is used in excess of its solubility. That is the question that was decided in the *Miami* case. As to that the Circuit Court of

Appeals in the instant case further said (R., Vol. I, pp. 651, 652):

> "In the *Miami Copper* case, *supra,* the litigation involved both patent No. 835,120 and the patent here in suit No. 962,678. The agent employed by the defendant in its infringing process was partly soluble and partly insoluble, and the use of such an agent in a fraction of one per cent on the ore was held to infringe both patents on the ground that it was a conjoint use of both. While such use was *plainly within the scope of the disclosure of the first patent* (No. 835,120) and an infringement of it, it was not within the scope and an infringement of the second patent, for even assuming that the second patent is valid, its scope, as previously pointed out, is limited to the use of an agent that is wholly in solution in water. This being so, the use of the agent there employed was not within the scope and an infringement of the second patent. *We, therefore, decline to follow the decision in the Miami case.*"

It will be noted that the Circuit Court of Appeals in the instant case seemed here, when speaking of 835,120, to confuse "scope of the disclosure" with scope of the claim; and further they overlooked or failed to comprehend the testimony as to the complex nature of the materials used where those materials contained not only substances which are insoluble mineral-frothing agents but also entirely different substances which are soluble mineral-frothing agents and were not used in excess of their solubility. The disagreement, however, with the Circuit Court of Appeals for the Third Circuit covered the whole subject of the validity of the patent here in suit, to wit, the whole scope of the opinion of the Circuit Court of Appeals in the instant case.

The conflicting decision in the Third Circuit Minerals Separation, Limited v. Miami Copper Company.

Three patents were in suit in that case. The first was No. 835,120, the patent held in the instant case to anticipate the patent in suit. The second was No. 962,678, the patent here in

suit. The third was No. 1,099,699, which is in evidence here. All three were there held to be valid and infringed.

The first patent No. 835,120 was pleaded as an anticipation of the second patent, the patent here in suit. The Cattermole patent No. 777,273 and the Cattermole, Sulman & Picard patent No. 777,274 were there also before that Court as alleged anticipations of the second patent there, the patent here in suit, and the effect of the references in patent No. 835,120 to these two Cattermole patents and the reference in the patent here in suit to the last mentioned Cattermole patent, were very fully argued. Indeed the only patent referred to in the decision of the Circuit Court of Appeals in the instant case which was not before the Circuit Court of Appeals for the Third Circuit in the *Miami* case and there considered as an alleged anticipation of the patent here in suit, is the New Zealand patent held by the Circuit Court of Appeals in the instant case to confirm its construction of patent No. 835,120, erroneously as we have seen.

The argument in the Circuit Court of Appeals in the *Miami* case occurred after the decision in this Court in *Minerals Separation, Limited* v. *Hyde* (Dec. 11, 1916). The decision in the *Miami* case preceded the decision of this Court in *Minerals Separation, Limited* v. *Butte & Superior Mining Company* (June 2, 1919). Hence we find in the decision in the Third Circuit in the *Miami* case a careful consideration of the decision of this Court in the *Hyde* case, and we find in the decision of this Court in the *Butte & Superior* case that the *Miami* case is cited in a footnote (250 U. S. at 338) as one of the cases wherein patent No. 835,120 had been described in court proceedings.

Judges Buffington, McPherson and Woolley, Circuit Judges, heard the argument, and the opinion of the Court was written by Judge Woolley. Judge Buffington dissented, but his dissenting opinion only discussed the construction of patent No. 835,120 and the question of infringement of that patent.

In pointing out the difference between the first and second patents there in suit, Judge Woolley said of the process of the second patent, the patent here in suit (244 Fed. at 771):

"It is also an air-froth flotation process but differs from the first patent, although both processes may be, and both actually are, employed conjointly. Its essential feature is the use of a mineral-frothing agent in solution."

After quoting at large from the specification, including claims 1 and 2 which were there and are here in suit, and also including claims 5 and 6 which were there additionally in suit and which included "beating air into" the pulp, Judge Woolley continues (p. 773):

"The difference between the two patents may be shortly stated to be this: The first process rests upon the use in very small quantity of an oily substance that does not dissolve in water, coupled with agitation of the pulp, and this succeeds in producing a special froth that is remarkably effective in recovering the minute particles of ore. The second process does not employ oil, or an undissolvable substance; on the contrary, the 'mineral-frothing agent' must be in solution, and ex vi termini must therefore be dissolvable. The specification disclaims the use of so large a quantity that part of it remains undissolved. The 'mineral-frothing agent' is further limited by describing it as 'one or more organic substances which enable metallic sulfids to float under conditions hereinafter specified'; and, as this general statement does not convey specific information, the patentees give several examples of organic substances that are found to be suitable for use in solution. In passing we may note that claims 1 and 5 are broad enough to cover inorganic frothing agents also, but as no such agent is yet known this feature need not now be considered. Just how or why this solution with the needful agitation produces the froth, is not certainly known; but the fact is, that (to use the language of the brief):

'* * * Its effect [is] to produce a similar action of air bubbles in the attraction of metallic particles, a similar levitation of the metallic particles, a similar persistence of the bubbles, a similar reliable adherence of the air bubbles to the metallic particles, and a similar capacity for final separation of the metallic particles by their overflow, still in attachment to air bubbles, at the top of a vessel containing the pulp.'

> "An observable difference in effect is that the froth of the second patent is composed of bubbles much smaller than the bubbles of the oil process. * * *
>
> "We do not find it necessary to discuss the question of validity; our conclusion is, that the patent discloses invention and has not been anticipated. As in the case of the oil process, the patentees seem to have taken 'the final step which converted experiment into solution, turned failure into success.' *Minerals Separation Co.* v. *Hyde,* 242 U. S. 261, 37 Sup. Ct. 82, 61 L. Ed. 286. And we find nothing in the prior art that can be held to anticipate."

It will be noted that the Circuit Court of Appeals for the Third Circuit, after stating that the distinguishing feature of the process of the patent here in suit No. 962,678 is the use of a mineral-frothing agent in solution, defines that agent as follows:

1. It "must be **in solution,** and ex vi termini must therefore be dissolvable"; in contrast to the undissolvable substance, oil, of 835,120.

2. It must be a **"mineral-frothing agent"** which is further defined and limited by describing it as **"one or more organic substances which enable metallic sulfids to float under conditions hereinafter specified."**

Summary and authorities as to conflict between the Circuit Court of Appeals for the Third Circuit in the Miami Case and the Circuit Court of Appeals for the First Circuit in the instant case as to Anticipation of the Patent in Suit by Patent No. 835,120.

The two Courts had the same documents before them, with a few minor exceptions, the only one referred to in the opinion of the Circuit Court of Appeals for the First Circuit being the New Zealand patent heretofore discussed which we have shown does not alter the situation one iota.

The two Courts had the same facts before them excepting only the speculative theories of defendant's experts but we have

shown that those theories do not change or alter by a hair's breadth the disclosure of patent No. 835,120.

The facts presented to the two Courts on the issue of anticipation were the same.

While the Circuit Court of Appeals for the Third Circuit in the *Miami* case did not find it necessary to discuss the question of validity of the patent here in suit, No. 962,678, claims 1 and 2, and merely stated its conclusion "that the patent discloses invention and has not been anticipated * * * and we find nothing in the prior art that can be held to anticipate," they accurately stated the differences between the two patents, Nos. 835,120 and 962,678, and accurately compared the defendant's process there with the claims of patent No. 962,678 and concluded as to the process of the patent here in suit:

> "as in the case of the oil process, the patentees seem to have taken 'the final step which converted experiment into solution, turned failure into success' *Minerals Separation Company* v. *Hyde,* 242 U. S. 261, 37 Sup. Ct. 82, 61 L. ed. 286."

The Circuit Court of Appeals for the First Circuit in the instant case made error after error as we have pointed out, errors of fact on the technical side, misunderstanding processes and descriptions of processes and misinterpreting technical terms of the art, and made errors of law in misinterpreting decisions of this Court and in substituting speculative theories, unproved and unprovable, for the simple facts set out simply in the documents under comparison, demonstrated by the simple tests of those who were expert in the practical art, evidenced by the simple and straightforward reasoning and opinions and experience of those practical experts, and conclusively established by the history of the practical art before and after the advent of the process of the patent in suit.

The conclusion that the Circuit Court of Appeals for the Third Circuit was right and that the Circuit Court of Appeals for the First Circuit is wrong is fortified by *the presumption arising from the issue of the patent* in suit four years after the issue of the patent No. 835,120.

In *Gandy* v. *Main Belting Co.*, 143 U. S. 587, the lower Court had dismissed the bill on several grounds, one being that of anticipation. In this court the defenses of lack of novelty and lack of patentability were vigorously asserted, but this Court sustained the patent, saying:

> " 'The patent is *prima facie* evidence both of novelty and utility, and neither of these presumptions has been rebutted by the evidence.' "
> *Railroad* v. *Stimpson*, 14 Peters, 448;
> *Corning* v. *Burden*, 15 How. 252;
> *Blanchard* v. *Putnam*, 8 Wall. 420;
> *Mitchell* v. *Tilghman*, 19 Wall. 287;
> *Bates* v. *Coe*, 98 U. S. 31.

The conclusion that the Circuit Court of Appeals for the Third Circuit was right and that the Circuit Court of Appeals for the First Circuit in the instant case is wrong is further fortified by *the proved benefit* that the inventors by the process of the patent in suit have *conferred upon society*, a boon to the metallurgical world of unprecedented magnitude, and by the *enormous public demand* for and use of the process and by the *almost universal acquiescence* of the public in the validity of the patent in many cases after years of litigation.

The final solving of the problem of the flotation of the porphyry copper ores, the world's greatest source of copper, by the process of the patent in suit, makes it and makes this case almost unique in the history of patent law in this country.

This Court said in *Eibel Process Co.* v. *Minn. & Ont. Paper Co.*, 261 U. S. 45, 54, of the far less important contribution to society:

> "Our conclusion is confirmed * * * by the circumstances, uncontroverted, that the owners of these fastest machines at once, upon Eibel's publication of his discovery, adopted his pitch and increased their product. * * * The fact that the Eibel pitch has thus been generally adopted in the paper making business, and that the daily product in paper making has thus been increased at least twenty per cent over that which had been achieved before Eibel, is very weighty evidence to

sustain the presumption from his patent that what he discovered and invented was new and useful."

In *Minerals Separation, Ltd.* v. *Hyde,* 242 U. S. 261, 270, this Court said of the process of patent No. 835,120 (and the process of the patent in suit is a younger and a greater brother):

> "that the process in suit was promptly considered by the patentees as an original and important discovery, * * * it promptly came into extensive use * * * it has largely replaced all earlier processes. This, of itself, is persuasive evidence of that invention which it is the purpose of the patent laws to reward and protect."

In *Benjamin Co.* v. *Northwestern Co.,* 251 Fed. 288, 294, Judge Hough said for the Circuit Court of Appeals of the Second Circuit:

> "Prompt and extensive use plus displacement of earlier devices is 'of itself' persuasive evidence of invention (*Minerals Separation* v. *Hyde,* 242 U. S. at 270, 37 Sup. Ct. 82, 61 L. Ed. 286), a form of statement stronger, we think, than has before fallen from that court on this subject."

The Circuit Court of Appeals for the First Circuit in the instant case in upholding the defense of anticipation on surmise and conjecture and disputed theory and discredited speculation, and really, with all respect, in fundamental ignorance of the subject matter, failed to apply the rule of law that *the burden is on a defendant to prove an affirmative defense.*

In *Cantrell* v. *Wallick,* 117 U. S. 689, this Court said, in speaking of the defenses of prior use and want of novelty:

> "The burden of proof is upon the defendants to establish this defense. For the grant of letters patent is *prima facie* evidence that the patentee is the first inventor of the device described in the letters patent and of its novelty. *Smith* v. *Goodyear Dental Vulcanite Co.,* 93 U. S. 486; *Lehnbeuter* v. *Holthaus,* 105 U. S. 94. Not only is the burden of proof to make good this defense upon the party setting it up, but it has been held that

> 'every reasonable doubt should be resolved against him.' *Coffin* v. *Ogden*, 18 Wall. 120, 124; *Washburn* v. *Gould*, 2 Story, 122, 142."

In *Smith* v. *Goodyear Dental Vulcanite Co.*, 93 U. S. 486, this Court said:

> "The patent itself is *prima facie* evidence that the patentee was the first inventor; at least, it casts upon him who denies it the burden of sustaining his denial by proof."

The Circuit Court of Appeals for the First Circuit in the instant case also failed to apply *the rule as to anticipation by a prior document* that the disclosure contained in the prior document must be full and clear and must certainly disclose the very invention in issue.

In *Seymour* v. *Osborne*, 11 Wall. 516, 555, Mr. Justice Clifford said:

> "Mere vague and general representations will not support such a defense, as the knowledge supposed to be derived from the publication must be sufficient to enable those skilled in the art or science to understand the nature and operation of the invention, and to carry it into practical use."

Nobody skilled in the art derived at the time of its issue, or afterward, from patent No. 835,120 knowledge sufficient to enable him to understand the nature and operation of the invention of the patent in suit No. 962,678 and to carry the process of the patent in suit into practical use.

In *Cohn* v. *Corset*, 93 U. S. 366, 370, Mr. Justice Strong said:

> "It must be admitted that, unless the earlier printed and published description does exhibit the later patented invention in such a full and intelligible manner as to enable persons skilled in the art to which the invention is related to comprehend it without assistance from the patent, or to make it, or repeat the process claimed, it is insufficient to invalidate the patent."

This rule was affirmed in *Downton* v. *Yeager Milling Co.*, 108 U. S. 466, 471, and in *Eames* v. *Andrews*, 122 U. S. 66. See also *Railroad Co.* v. *Turrill*, 4 Otto 695, 704.

Patents are to be liberally dealt with on the question of validity under the rule *ut res magis valeat quam pereat.*

In *Turrill* v. *R. R. Co.*, 68 U. S. 491, 510, 17 L. Ed. 668, 672, Mr. Justice Clifford said:

> "Patents for inventions are not to be treated as mere monopolies and, therefore, odious in the eyes of the law; but they are to receive a liberal construction, and under the fair application of the rule, *ut res magis valeat quam pereat*, are, if practicable, to be so interpreted as to uphold and not to destroy the right of the inventor."

In *Rubber Co.* v. *Goodyear*, 9 Wall. 788, 795, Mr. Justice Swayne said:

> "But liberality, rather than strictness, should prevail where the fate of the patent is involved, and the question to be decided is whether the inventor shall hold or lose the fruits of his genius and his labors."

In the instant case and considering the interval in the art from the date of issue of patent No. 835,120 in 1906 to the time of the making of the invention of the patent in suit, No. 962,678 in or about 1909, the evidence is clear and undisputed that *the men skilled in the art did not then find in the disclosure of patent No. 835,120 the invention of patent No. 962,678.* Sulman, Picard, Higgins, Chapman, Greenway and others were the most expert and the most experienced in this art at that time. They were connected with such commercial applications of the process of patent No. 835,120 as occurred during that period and some of them toward the end of that period, under pressure of litigation in England on the Elmore patents for the use of an acidified pulp in an oil flotation process, were eagerly seeking a froth-flotation process *that would avoid the use of oil.* The ultimate outcome of that litigation in 1910 in the House of

Lords and in the Privy Council in 1914 freed the oil process of patent No. 835,120 from the domination of the Elmore patents in that regard because of the microscopic quantity of oil employed, but during the period in question that outcome could not be confidently predicted and the threat against the entire enterprise of plaintiff's predecessor in business was very great. If the present conclusion of the Circuit Court of Appeals for the First Circuit in the instant case that the invention of patent No. 962,678 stood all the time disclosed in patent No. 835,120, that eager effort of the experts at that time to avoid the Elmore patents was all wasted effort. But, as this Court has said, on such a matter the judgment of those expert in the art is the safest guide. What the Circuit Court of Appeals for the First Circuit found in patent No. 835,120 in January, 1929, none of the experts in the art found or could find in it during the period in question.

As was said by this Court in *Potts* v. *Creager*, 155 U. S. 597, 608, in a somewhat analogous situation,

> "*The practiced eye of an ordinary mechanic* may be safely trusted to see what ought to be apparent to everyone."

As the late Judge Hough said for the Circuit Court of Appeals for the Second Circuit in *Kurtz* v. *Belle Hat Lining Co.*, 280 Fed. 277,282, on the related question of obviousness as against invention, the Court should not substitute its "own experience" for "the eyes of the hat lining trade."

See this Court to the same effect in *Carnegie* v. *Cambria Iron Works*, 185 U. S. 403. As Judge Learned Hand said for the Circuit Court of Appeals for the Second Circuit in *Dubilier Condenser* v. *New York Co.*, 20 Fed. (2d) 723,

> "In all inventions *the safest test* is the condition of the art before and after the putative invention appears. At least that is an immeasurably safer test, when available, than any *a priori* conclusion as to what is or is not an obvious step. To the last we should not resort, except in cases of absolute necessity."

The revolutionary advent in the commercial froth-flotation art of the invention of the patent in suit, No. 962,678, did not occur when the now alleged disclosure of that process in patent No. 835,120 occurred. If it had that fact would have tended strongly to confirm the conclusion of the Circuit Court of Appeals for the First Circuit in the instant case. The fact that it did not occur to any one during the interval between 1906 and 1909, though such a process omitting oil was eagerly sought, tends strongly to refute that conclusion.

We submit that it is clear that the patent in suit, No. 962,678, is not anticipated by patent No. 835,120 and that the District Court and the Circuit Court of Appeals for the Third Circuit in the *Miami* case and the District Court in the instant case were right in so holding and that the Circuit Court of Appeals for the First Circuit in the instant case (or a majority of that court) erred in holding to the contrary.

INFRINGEMENT.

The trial Judge very fully considered the question of infringement and held that the defendant's operations infringed claims 1 and 2 of the patent in suit. Demonstrations were made during the trial including the showing in small mill-size apparatus installed in Boston, of the operation of the process of the patent in suit as carried on by the defendant. Offers were made during the argument in the Circuit Court of Appeals to repeat these demonstrations, but were declined. The Circuit Court of Appeals did not see any demonstrations. Its opinion does not discuss the question of infringement. Therefore the findings of the trial Judge as to infringement stand unassailed.

We, therefore, show only the facts as to defendant's operations, from which infringement is manifest.

The facts as to infringement fully appear by stipulation (R., Vol. I, pp. 103-106). The defendant by water-concentration operations prepared a product known as the drag-classifier overflow, containing only about 2.2% of copper (R., Vol. I, p. 105) with the ore finely ground so that it would all pass through a 60-mesh screen (p. 104) and carried in water with a relation of

water to solids of about 5 to 1. This pulp also carried a small amount of lime which was added with the ore and water to the feed to the first ball mill (p. 103). This pulp was flowed into Callow pneumatic cells, and into these cells was also flowed a solution of alpha-naphthylamine (X-cake) of the strength of one part of X-cake to 1000 parts of water (p. 105). The proportion of X-cake to ore was a little less than half a pound of X-cake to a ton of ore (which as we shall show, makes less than one part of X-cake to 20,000 parts of water in the pulp). Air was blown into these pneumatic cells through the porous inclined bottoms thereof and by it the pulp was vigorously agitated, a great number of minute air bubbles formed, the ore particles were brought into contact with the air bubbles, and the result was that a froth carrying the metallic sulphide particles of the ore floated upon the surface of the pulp and overflowed, carrying with it the sulphide particles in a concentrate, in this instance called a rougher concentrate. The rougher concentrates produced in two large, rougher pneumatic cells were flowed into a smaller cleaner pneumatic cell, where the operation above described was repeated and the froth overflowed as a finished product. The Callow pneumatic cells or flotation cells above referred to, of which there were 4 roughers and 2 cleaners, were known as the upper flotation cells. There was then some treatment by water or gravity concentration over Wilfley shaking tables of the depleted pulp flowing out of the rougher pneumatic cells, which recovered a small amount of the coarse material as a finished concentrate and passed on their tailings to the lower flotation cells. It may be noted that the tailings of the upper cleaner cells and the middlings of the Wilfley tables were sent back to the circuit so as to be elevated and again put through the drag classifier.

The lower flotation cells comprised 2 rougher cells which divided between them the tailings of the Wilfley tables and sent their own tailings to waste, i.e., to the ponds in which the solids were allowed to settle so that the water could be pumped back and used over again in the mill, while the overflow froths from these rougher cells was pumped to a single cleaner cell the overflow froth of which was a finished concentrate and the tailings

of which were returned by a pump to the head of the lower flotation cells.

Thus the defendant carried on in nine Callow pneumatic cells the operations of agitating a pulp of powdered ore and water, the water containing in solution a small quantity of a mineral-frothing agent, and of agitating this mixture to form a froth and separating the froth, as pointed out in claim 1, and the mineral-frothing agent in solution was an organic mineral-frothing agent, as additionally required by claim 2.

The operation may be described in the language of the patent in suit. "The crushed ore" in these pneumatic cells "is mixed with water containing in solution a small percentage of a mineral-frothing agent," "the mixture is thoroughly agitated," "the gas [air] is effectively introduced into the mixture, and the ore particles come in contact with the gas [air] and the result is that metallic sulphide particles float to the surface in the form of a froth," which is "separated by" overflowing.

As suggested in the specification the tailings are retreated by the same process without the addition of fresh quantities of the mineral-frothing agent, i.e., the tailings of the upper flotation roughers, after having some coarse material taken out of them in passing over the Wilfley tables, are retreated in the lower flotation roughers and the tailings of the latter go to waste.

The solubility of alpha-naphthylamine is .17 parts in 100 parts of water, or 1.7 parts in 1000 parts of water (17 pounds in 10,000 pounds of water). This figure was given by Mr. Wilding (R., Vol. I, p. 163, RDQs325-328) and his testimony giving further authorities (RDQ327) was interrupted by Mr. Davis, who said "That figure satisfies us." Defendant's solution of alpha-naphthylamine which was fed to its ore pulp contained only 1 part of alpha-naphthylamine to 1000 parts of water (Stipulation, R., Vol. I, p. 105, 3rd paragraph) so that there was complete solution. This ore pulp was the overflow from the drag classifier and contained between 16% and 17% of solids (Stipulation, R., Vol. I, p. 105, last paragraph) and was therefore 83% to 84% water, and the pulp approximately a 5 to 1 pulp. Therefore for every ton of ore there were 5 tons, or 10,000 pounds of water, which would have dissolved 17 pounds of

alpha-naphthylamine, whereas the amount used was 0.
pounds, or less than one-half a pound per ton of ore, which w
obviously completely dissolved.

It is submitted that the decree of the Circuit Court of A
peals should be reversed, and the decree of the District Co
affirmed.

Very respectfully,

HENRY D. WILLIAMS,
WM. HOUSTON KENYON,
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Dated, New York, N. Y., November 11, 1929.